HCERES

High Council for the Evaluation of Research and Higher Education

Research units

HCERES report on research unit:

Institut de Planétologie et d'Astrophysique de Grenoble

IPAG

Under the supervision of the following institutions and research bodies:

Université Joseph Fourier - Grenoble - UJF

Centre National de la Recherche Scientifique - CNRS

Evaluation Campaign 2014-2015 (Group A)

HCERES

High Council for the Evaluation of Research and Higher Education

Research units

In the name of HCERES,[1]

Didier HOUSSIN, president

In the name of the experts committee,[2]

Jean-Marie HAMEURY, chairman of the committe

Under the decree N°.2014-1365 dated 14 november 2014,

[1] The president of HCERES "countersigns the evaluation reports set up by the experts committees and signed by their chairman." (Article 8, paragraph 5)

[2] The evaluation reports "are signed by the chairman of the expert committee". (Article 11, paragraph 2)

Evaluation report

This report is the result of the evaluation by the experts committee, the composition of which is specified below.

The assessments contained herein are the expression of an independent and collegial deliberation of the committee.

Unit name:	Institut de Planétologie et d'Astrophysique de Grenoble
Unit acronym:	IPAG
Label requested:	UMR
Present no.:	5274
Name of Director (2014-2015):	Mr Jean-Louis MONIN
Name of Project Leader (2016-2020):	Mr François-Xavier DÉSERT

Expert committee members

Chair:	Mr Jean-Marie HAMEURY, Université de Strasbourg
Experts:	Ms Caroline BARBAN, Observatoire de Paris (representative of CNAP)
	Ms Carine BRIAND, Observatoire de Paris (representative of CoNRS)
	Mr André CHARDIN, Université Paris-Sud
	Mr David CLARY, Oxford University, United Kingdom
	Mr John Kirk, Max-Planck-Institut für Kernphysik, Germany
	Mr Marc OLLIVIER, Université Paris-Sud
	Mr Francesco PALLA, Osservatorio Astrofisico di Arcetri, Italy
	Mr Cyril SZOPA, Université Pierre-et-Marie-Curie (representative of CNU)

Scientific delegate representing the HCERES:

Mr Michel BLANC

Representative(s) of the unit's supervising institutions and bodies:

Mr Jean BRAUN (Director of Doctoral School n°105, ED TUE)

Mr Alain CARTELIER, UJF

Mr Johann COLLOT (Director of Doctoral School n°47, ED Physique)

Mr Christian COMMAULT (Director of Doctoral School n°220, ED EEATS)

Mr Olivier LAMARLE, CNES

Mr Denis MOURARD, CNRS/INSU

Mr Francis ROCARD, CNES

Mr Jérôme VITRE, CNRS/DR11

1 • Introduction

History and geographical location of the unit

IPAG results from the merging on January 1st, 2011 of two research units: LAOG (Laboratoire d'Astrophysique de l'Observatoire de Grenoble), and LPG (Laboratoire de Planétologie de Grenoble). LAOG and LPG were created 30 years and 10 years respectively before the merging, both from very small initial groups. IPAG is located on the UJF campus, hosted in three buildings separated by approximately 200 m. They are next to the IRAM (Institut de Radioastronomie Millimétrique) building which hosts the French-German-Spanish institute operating two international major facilities located in "Plateau de Bure" and in Spain, and which is the other astronomical institute in Grenoble (albeit with a specific, international status).

Management team

Director: Mr Jean-Louis MONIN; Deputy directors: Mr Jérôme BOUVIER and Mr Sylvain DOUTÉ.

Technical director: Mr Étienne Le COARER.

HCERES nomenclature

ST3 (Earth and Universe sciences)

Unit workforce

Unit workforce	Number as at 30/06/2014	Number as at 01/01/2016
N1: Permanent professors and similar positions	34	32
N2: Permanent researchers from Institutions and similar positions	24	23
N3: Other permanent staff (without research duties)	36	34
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)	2	2
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	15	4
N6: Other contractual staff (without research duties)	8	
TOTAL N1 to N6	**119**	**95**

Unit workforce	Number as at 30/06/2014	Number as at 01/01/2016
Doctoral students	29	
Theses defended	25	
Postdoctoral students having spent at least 12 months in the unit	2	
Number of Research Supervisor Qualifications (HDR) taken	6	
Qualified research supervisors (with an HDR) or similar positions	38	35

2 • Overall assessment of the unit

Global assessment of the unit

IPAG is a top-level laboratory for astrophysics and planetary sciences in France. Impressive scientific results have been obtained since the last AERES visit, thanks in particular to the exploitation of major space and ground-based facilities such as ALMA, IRAM, Planck, Herschel, VLT, HESS, Fermi, etc., and to the development of theoretical models to interpret these data. The laboratory also had major contributions in instrumental developments such as SPHERE, PIONIER, Rosetta/Consert, etc. which are now providing exciting data and are promises for great scientific achievements in the next few years. These successes are due both to an adequate strategy developed in the past and to the excellence of many individual staff members, both from the research teams and from the technical group. IPAG visibility at national and international levels is very good; there is however, given the excellence of the scientific results, room for some improvement in a few areas, in particular with respect to the U.S. community.

A new director for IPAG will be appointed in 2015, and the nomination process had just started before the visiting committee; the committee had the opportunity to interview the prospective director. This move should not affect the future scientific strategy, which the committee found to be sound, but will certainly have an effect on the general organization of the unit. The committee was able to assess the general philosophy of the proposed management scheme and found it appropriate, but did not consider the details of the reorganization that are likely to change.

Strengths and opportunities in relation to the context

The strength of IPAG relies first on the high quality of the staff, on the quality of the scientific results, and on the technical achievements. The number of publications in refereed journals is large (more than 1000 over the reference period, *i.e.* more than 3 publications per permanent researcher per year), and their quality is high as well. The arrival of Rosetta on the comet, the first light of SPHERE were major events for the international scientific community in which IPAG played a key role. The strength of the technical group relies in part on long-term R&D activities that enabled the proposal, approval and realization of cutting edge instruments.

IPAG also benefits from a high quality scientific environment in Grenoble. The current reorganization of the universities, the creation of a research pole PAGE (Physique des Particules, Astrophysique, Géosciences, Environnement) will help developing and strengthening relations in the high energy and astroparticle domain. The creation of a "student spatial centre" in Grenoble is another opportunity that IPAG must grasp, with a careful monitoring of human resources devoted to this project, though. The successes of two LabEx projects (OSUG@2020 and FOCUS) guarantee some resources on the long term, which partly alleviate the reduced funding via ANR. The age distribution of IPAG staff is also wealthy, and retirements should not be a major problem in the medium term, even if some departures will occur and may have significant effects. In addition, the FOCUS LabEx is a tool for strengthening the coherence of the R&D activity, and will certainly enable stronger links with the Service d'Astrophysique of CEA in Saclay and with CEA/LETI in Grenoble.

The merging of LPG and LAOG occurred 4 years ago and can be viewed as a success, despite the difficulties inherent to this major evolution. The committee noted significant scientific interactions between the planetology group and other teams at IPAG, and the creation of a technical group has had positive effects for all teams.

Weaknesses and threats related to the context

The rapid growth of the two laboratories whose merging gave birth to IPAG seems to be over now. The management team (present and prospective) is well aware of this, but opportunities for new developments should not be neglected, however. This will require a delicate balance of ambition and realism.

The organization and management structure had to be adapted shortly after the creation of IPAG to the new size of the unit, and there is still a need to check that the present organization is well adapted to the scientific objectives and size of the unit. The committee agreed upon the scheme proposed for evolution, but this will need an active support of the IPAG staff to be implemented in a successful way, and it is not unusual that changes generate tensions. Convincing the staff of the need for such changes and their adequacy with IPAG needs will clearly be an immediate, important task of the future IPAG director.

Despite the growth of IPAG, some projects rely on very few individuals having a crucial expertise, making them quite sensitive to *e.g.* departures. Recruitments would solve this problem, but it is not clear that they can possibly cover all the needs.

Recommendations

- IPAG management and staff must be ambitious, given the high scientific quality of the unit. Reinforcing the international visibility should be a priority. Several teams have the capacity to host an ERC at senior level, and applications should be encouraged;
- the next major step for instrumentation for exoplanet imaging will be the planet finder for the ELT (PCS). A roadmap should be developed for attaining this long-term goal, which will include contributions to the first light ELT instruments and a careful planning of long term R&D activities;
- the creation of a technical group 5 years ago, together with the creation of an instrumental team (CRISTAL) was a good move which should go further with the transformation of CRISTAL into a transverse axis, in support to scientific teams;
- links with IRAM have been strengthened in the recent past, in particular with the signature of an agreement between UJF and IRAM, but they must be much more developed;
- all but one of the 10 researchers recently recruited at IPAG defended their PhD thesis in Grenoble. Opening the recruitments by attracting excellent external candidates would certainly be desirable, and would also help to improve the international visibility of IPAG;
- the number of PhD students is still low, and the IPAG management should do its best efforts to attract them (and find the corresponding funding).

3 • Detailed assessments

Assessment of scientific quality and outputs

IPAG scientific production relies on the adequate mix of theory, modelization, observations, instrumentation, and laboratory experiments combined in a very efficient and productive way. Despite the relatively broad range of domains touched upon at IPAG, there is a global coherence, which is one of the reasons for the many cooperations between teams.

Important results have been obtained during the past 5 years, which will be developed in the following sections. IPAG has obtained several firsts, as *e.g.* the detection of the first super-Earths in the habitable zone of their host stars, and the discovery of gamma-ray binaries, just to mention only two examples. The general context of the period 2009-2014 was very good for astronomy, as facilities such as Planck, Herschel, ALMA, Rosetta became available for producing data, and IPAG took the full benefit of these opportunities.

Instrumental developments have also been outstanding. SPHERE is by far the largest instrument built under the responsibility of IPAG, with a total consolidated cost on the order of 20 M€. It has obtained its first light at the VLT and will be a workhorse Instrument for the exoplanet community; the first images of the planet β Pic b are already impressive. PIONIER, the first instrument which can recombine the light from 4 telescopes on the VLTI, is now open to the whole community and is producing impressive results. This is a show case of cutting edge R&D developments on detectors (RAPID technology) and integrated optics that have been used to build a simple, but very efficient instrument. The radar CONSERT on the Rosetta probe – built 15 years ago under the responsibility of LPG – has arrived at the comet 67P/Churyumov-Gerasimenko and is now providing data. The radar expertise at IPAG is unique, and this is the reason why, although IPAG did not contribute to any hardware, it could host the PI of the CONSERT instrument; this is a rather unique situation for instruments which are developed in consortia of academic laboratories.

IPAG also contributed in a very significant way to "Services d'Observation" which are service activities for the benefit of the national (and international) scientific community. They are under the responsibility of regional Observatories (OSUG for Grenoble), and the contribution of IPAG has been major. This is true of course for instrument building, as noted above, but also for data centres and databases such as the Jean-Marie Mariotti Centre in charge of developing and distributing software and services for the exploitation of optical interferometers, or GhOSST, which is an experimental database of spectroscopic and thermodynamic properties used in planetology and astrophysics.

These achievements can be measured by the number of publications, more than 1000 over the reference period in refereed journals, *i.e.* more than 3 per permanent researcher per year, including about 20 in Nature, Science or Phys. Rev. Letters. These publications had a very significant impact: the average number of citations per article published over the period 2009-2014 in the European journal Astronomy and Astrophysics in which a member of the permanent staff was a co-author is 2.5 times larger than the average for A&A (2 times if one restricts to a first author from IPAG; this also removes publications from the Planck mission, which were by far the most quoted papers during the past few years).

These successes are due to the quality of the research staff and the technical staff. They are also due to a careful planning, for which the whole laboratory and the management team must be commended.

Short appreciation on this criterion

IPAG works on very active scientific fields and plays a major scientific role in these at the international level. There are indeed differences between teams, but no significant weakness has been noted. The technical capacities are important and combine in a very fruitful way expertise in instrument building and R&D activities. The global scientific quality and outputs of the unit are outstanding.

Assessment of the unit's academic reputation and appeal

The national and international visibility can be measured by the impact of the scientific publications, as noted above. It can also be measured by the success rate to various announcements of opportunity: observing time, which ultimately results in publications; instrument building (see above); and project funding. One can note that IPAG has won 21 ANR projects between 2009 and 2014, being PI of 2/3 of them. IPAG has also been selected for one ERC

starting grant in 2013, making it the second ERC grant at IPAG (the previous one was selected for the 2007 program). The selection of the LabEx FOCUS, whose PI is at IPAG, must also be noted.

Several IPAG members belong to, or chair various national committees and have recently received distinguished prizes and medals. IPAG is also part of the EU FP7 consortium OPTICON in charge of structuring the European astronomical community in the optical domain and is the lead of two of the 6 JRA workpackages of OPTICON. IPAG members are or have been also present in several ESO or ESA committees, or in ESFRI expert committees. IPAG also hosted or contributed to the organization of several international workshops or conferences.

The international visibility is thus very good at the national and international levels. The committee noted however that, given the quality of the results, it could be increased in some areas, in particular in the U.S.. A more aggressive attitude could help in some cases; attracting more excellent post-docs who would then become good candidates for recruitment on a permanent position would also be very positive in this respect. The committee noted that IPAG has not benefited from individual Marie-Curie grants in the past 5 years, and certainly encourages IPAG to submit more applications.

Short appreciation on this criterion

The national and international reputation of IPAG is very good. Given the excellence of the scientific results, it can however still be improved in the U.S. in some areas.

Assessment of the unit's interaction with the social, economic and cultural environment

IPAG has a strong R&D activity that could be maintained even during the construction period of SPHERE, despite the strong pressure on the technical staff induced by this activity. This upstream, long term activity is developed, as it should, with a final objective of development of instruments for astronomical observations (see the case of PIONIER for example). It also generates contacts with local companies, and is a source of technology transfer. R&D developments at IPAG have applications in other domains, including the general public (*e.g.* the development of fast, low noise detectors). IPAG has generated 2 start-ups, RSS (Resolution Spectra Systems) and FLI (First Light Imaging) between 2009 and 2014. Including the historical ALPAO, this is an excellent score for an astrophysical laboratory. This goes with significant resources (from the FOCUS LabEx, or from FUI grants). One should also mention several patents and licenses. The committee noted that the technical staff involved in these activities is quite motivated; it would however recommend that the scientific and financial return be increased for the research unit as a whole.

IPAG is also developing a significant outreach program. In addition to the usual activities (visitors, conferences, high-school programs, etc.), which do not go significantly beyond expectations, one should underline the "Moulins de Villancourt" project at Pont-de-Claix, a public centre focused on Earth and Space sciences, which includes a planetarium, and for which the IPAG involvement is large. IPAG has also developed the Planeterrella, a very successful instrument to explain the auroral physics to a large public, which received several prizes and is now present in many institutes worldwide

Relations with other laboratories on the campus are good on the average. The planetology team has developed several important collaborations with other laboratories in OSUG; the other teams have stronger links with physics laboratories on the campus, notably SHERPAS and to a lesser extent ASTROMOL. The creation of the Université de Grenoble-Alpes will be an opportunity to strengthen relations with other laboratories, in particular in Annecy.

Links with IRAM have slowly increased over the years. An important step has been the signature of an UJF-IRAM agreement in 2012; a rapid growth of the interactions between IRAM and IPAG is highly desirable and is possible; it would be beneficial to both parties.

Short appreciation on this criterion

The overall interactions with partners are excellent. An effort should however be made to develop interactions with IRAM.

Assessment of the unit's organisation and life

IPAG results from the merging of LPG and LAOG in 2011. Merging two laboratories is a long and complex process; the committee considers that it has been successful, even if it is not complete yet. Scientific links between

the Planeto team and other teams, in particular ASTROMOL and CRISTAL, have developed successfully. The presence of a strong instrumental group is an opportunity that has been grasped by the PLANETO team; the development of integrated high-resolution spectroscopy for planetology applications being a good example of this. IPAG is currently spread over three buildings; this is not in itself a major problem, given the proximity of these buildings, but it certainly does not help, also because the Planeto team is isolated in a single building. Current efforts by the management to generate more mix are certainly welcome, provided that the technical installations of the Planeto team, which have benefited from large investments, are preserved.

Communication within IPAG does not raise major problems, but appears to be perfectible, both from management to staff and from staff to management. There is a general feeling that the decision process is complex and somewhat opaque. The committee was however unable to ascertain whether this feeling results from organizational difficulties. The committee was nevertheless surprised to see that team leaders are not systematically invited to attend meetings of the Conseil de Laboratoire; they do have regular meetings chaired by the deputy director for science, but these do not cover all management aspects. Conversely, it happens that the management is not informed of initiatives taken by individuals or groups, which have a significant impact on the unit.

The integration of new staff (in particular temporary staff, post-docs, PhD students and technical staff on temporary contracts) is good. The AERES committee noted in 2009 a need for information in English (in particular for the web site). This has been corrected, although efforts are still needed as for *e.g.* a welcome booklet; some developments are being taken by various staff categories, and a federation of efforts by the management would be welcome.

The creation of a technical group, independent from the CRISTAL team, had a clearly positive effect. The adopted matrix organization is standard, but could be strengthened. The project dimension is very clear, but the service aspects need to be reinforced. Regular meetings of each service would for example be most useful, and would also contribute to improve communication.

CAMPI appears to be a very interesting tool for managing the technical activity and for the decision making process. Its principles (having internal reviews of all projects before they are submitted for external funding and checking that the requested resources are properly estimated and include adequate overheads in line with IPAG policy) are excellent. This does not duplicate services existing at the CNRS or UJF level. This is a new tool under development; improvements are still needed, but this move is very promising.

Short appreciation on this criterion

The organization and internal life is good. Merging LAOG and LPG has been successful, even if it is not complete yet.

Assessment of the unit's involvement in training through research

IPAG has a relatively broad spectrum of expertise and activities, and depends on three doctoral schools (EDs):

- ED47 « physique », for general astrophysics. Most of the PhD students at IPAG depend on this ED;
- ED105 « Terre, Univers, Environnement »;
- ED220 « Électronique, Électrotechnique, Automatique, Traitement du Signal ».

There are currently 23 PhD students at IPAG, with a fair fraction (> 40 %) of foreigners, thereby showing the attractiveness of the unit, who are rather evenly distributed across teams. The interactions between IPAG and the doctoral schools appear to be good, even for EDs in which IPAG is a very minor partner (EEATS in particular).

The integration and follow-up of students by IPAG is very good. The laboratory has set up a committee (Groupe d'Accompagnement des Doctorants) to monitor the quality of interactions between the PhD students and their supervisor, which complements the follow-up by the various EDs (usually in the form of written reports) and the "thesis day" organized at the research unit level. The committee also noted the organization by the students themselves of psychological support to PhD students as a group at IPAG level, with the help of psychologists from UJF, which appeared to be preventive rather than curative. The committee noted that PhD students at IPAG found it difficult to have formations close to their scientific interests; an increase of the offer might be beneficial. A significant fraction of students at IPAG have been offered the possibility of teaching. The follow-up of students after the completion of their thesis also appears to be very good, and IPAG researchers are clearly concerned with the future of their PhD students.

The duration of PhD theses appears to be within the norm of each ED, albeit very slightly longer. The research unit funds all extensions when these are needed, which certainly helps maintaining the duration of the thesis within reasonable limits. There is however some room for improvement, in particular for the thesis in planetology whose duration (41 months on average, but this is small number statistics) exceeds the initially planned duration. The total number of PhD students at IPAG is low. This point was already noted by the previous visiting committee, and the situation is not significantly different from what it was 5 years ago. The committee therefore reiterates the recommendation to increase the number of PhD students.

IPAG contributes to teaching at lower levels. At the master level, IPAG is the dominant contributor to the master A2P (mention Physique, spécialité Astrophysique, Plasmas et Planètes), one of six second-year specialities of the Master of Physics from the University Joseph-Fourier. IPAG also hosts the online national server for M2 internships in astrophysics, which was created at the initiative of, and funded by, IPAG. The involvement of IPAG at lower level appears to be in the norm. With high-level engineers involved in cutting edge R&D activities, IPAG should be encouraged to develop teaching activities in engineering schools.

One must finally point out that IPAG has played a pioneering role in the development of MOOCs (Massive Open Online Courses) in Grenoble.

Short appreciation on this criterion

IPAG displays a very good involvement in training through research, both for PhDs and at other levels.

Assessment of the strategy and the five-year plan

A new director for IPAG will be appointed in 2015, and the nomination process had just started before the committee's visit. The committee had the opportunity to interview the prospective director, who had not yet presented his project to the research unit. It appeared that the scientific strategy will be that described in the documents submitted to HCERES, and the committee was therefore able to properly evaluate it; on the other hand, the committee could not have in-depth discussions about changes proposed for the organization of the unit, as these need to be discussed internally and evolutions are certainly possible. This report, therefore, only comments on the general philosophy of the management structure, it being understood that it is not in the committee's remit to suggest how IPAG should be organized.

The scientific and instrumental 5-year plan is clear and sound. It relies on what caused the successes of IPAG in the recent past, on the instruments and facilities to be available in the next 5 years, and on the planning of national and European agencies. It is ambitious, perhaps too ambitious in some areas but this is better than not being ambitious enough. A lesson learnt exercise, in particular for SPHERE, should be performed in a near term future; the objective being to identify what should be changed in the organization to avoid difficulties that have occurred and to perform better in current or future projects.

The planet finder for the E-ELT (PCS) is a key element for the long-term future of IPAG. IPAG should develop and formalize a roadmap for attaining this goal. Participation in first light instruments on the ELT (Micado and Harmoni) is indeed part of the plan, which should also involve R&D activities. This plan must be coherent with the national and ESO plans; however, local initiatives with national support would certainly be welcome, as measured risk taking can, on the long term, open new options. It would also be good to develop and formalize such a roadmap for other R&D activities.

The strategy for a participation in the Cerenkov Telescope Array (CTA) project needs to be consolidated; the current instrumental developments on light concentrators are currently not in the CTA baseline; given the importance of CTA, the interest of the SHERPAS team and its visibility in the HESS and CTA consortia, this issue should be sorted out in close interaction with INSU. It is clear that the potential technical contribution will involve only limited human resources.

The present and planned involvement of IPAG in space projects at a scientific and/or R&D level is very good. Being involved at a PI level by relying on the unique expertise in niche areas (*e.g.* radars) is certainly feasible on the short and medium term, but may be more difficult on a longer timescale. The development of a student space centre in Grenoble is a unique opportunity that IPAG cannot miss. Care must however be taken that a nanosatellite is a satellite, and developments must follow the standard rules for space projects, which is costly on a HR point of view. In addition, all the requested expertise is currently not present at IPAG.

The committee has a positive perception of the general philosophy underlying the reorganization plan: scientific teams more involved in the management, more autonomous, and reduced in number. The transformation of CRISTAL into a transverse axis follows the evolution from GRILL to CRISTAL, and seems natural, as this is already the main role played by this team. This transverse role is nevertheless very important, and CRISTAL is a forum for technical discussions on instrumental and R&D projects. The committee had a short discussion on SHERPAS and ODYSSEY, which are currently the smallest teams. It recommends that the management pay careful attention to the high-energy group and its coherence in any restructuring plan. At the management team level, the only recommendation that can be made at present is to carefully define the roles and responsibilities of everyone, with a particular attention to the IPAG director, the deputy director in charge of resources and the technical manager.

Short appreciation on this criterion

The five-year strategic plan is sound; the general philosophy of the proposed reorganization is viewed in a positive way, but details will be important.

4 • Team-by-team analysis

Team 1: ASTROMOL

Name of team leader: Mr Bertrand LEFLOCH

Workforce

Team workforce	Number as at 30/06/2014	Number as at 01/01/2016
N1: Permanent professors and similar positions	7	6
N2: Permanent EPST or EPIC researchers and similar positions	5	4.5
N3: Other permanent staff (without research duties)		
N4: Other professors (PREM, ECC, etc.)		
N5: Other researchers (DREM, Postdoctoral students, visitors, etc.)	3	
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**15**	**10.5**

Team workforce	Number as at 30/06/2014	Number as at 01/01/2016
Doctoral students	4	
Theses defended	6	
Postdoctoral students having spent at least 12 months in the unit	2	
Number of Research Supervisor Qualifications (HDR) taken	1	
Qualified research supervisors (with an HDR) or similar positions	6	4

Detailed assessments

Assessment of scientific quality and outputs

ASTROMOL has the clear goal to understand the physical and chemical processes occurring in interstellar gas and dust. The emphasis is on star-forming regions of the solar type. The team has the special feature that theoreticians who do accurate calculations on the collisions involving small molecules link these results directly through additional simulations to astrophysical observations. Their systems chosen to study are well planned and relevant. The team has published numerous impressive papers in high quality astronomy as well as chemistry (e.g. Faraday discussions, J. Phys. Chem., J. Chem. Phys) journals, with a total of 242 papers over the reference period. Team members have also improved computational approaches and made detailed comparisons with laboratory experiments done elsewhere to validate their theoretical results.

Highlights include the study of water in protostars including the H/D fractionation on ices, collisional broadening and energy transfer computations on H_2O with H_2 and calculations on the chemical reactions involving N and H leading to NH_3 together with their interesting discovery of nuclear spin effects in this system. These calculations have linked to observations done through Herschel/CHESS, IRAM/ASAI and IRAM/TIMASS and have led to several important and highly cited collaborative papers. The survey of the polarisation maps of the continuum emission observed through Planck contributed to the validation of the Big-Bang inflationary model. The interaction with other IPAG groups such as PLANETO, SHERPAS and FOST is good.

Short appreciation on this criterion

The scientific production is very good; the team has obtained many important results, published in high quality journals, and well cited.

Assessment of the team's academic reputation and appeal

The reputation of the team appears to be good in France but there is little evidence of international recognition of ASTROMOL in terms of, for example, awards of prizes, election to academies, editorships of major journals or plenary lectures at international conferences, notably for the chemistry activities. The team does good work and deserves to be better known internationally. IPAG and ASTROMOL need to work more actively to make the members of the team visible overseas – for example through attending more international conferences and facilitating nominations for awards. ASTROMOL does not have such a high international profile as PLANETO or FOST.

Short appreciation on this criterion

The team reputation and visibility is very good, but, given the high quality of the results, could be improved overseas.

Assessment of the team's interaction with the social, economic and cultural environment

There are good interactions and outreach programmes with high schools. This activity is managed at the IPAG level.

Assessment of the team's organisation and life

The ASTROMOL team itself seems to be well managed. The future program will have closer links with PLANETO and there may be advantages for the ASTROMOL team to have offices nearer to that team.

Assessment of the team's involvement in training through research

The team, like others in IPAG, has a relatively small number of PhD students and postdocs. The PhD students seem to be integrated well into the university programs and are highly motivated.

Assessment of the strategy and the five-year plan

The future plan of ASTROMOL is ambitious. The aim is to study more complicated chemical networks with applications to protostellar regions, the primordial universe, cosmic ray effects and extragalactic systems. This will include considering chemical reactions involving complex organic molecules and reactions on ices. The promising work on calculating the effects of nuclear spins on chemical reactions will be extended from N to C and O atoms. Anomalous isotope effects of D and ^{15}N will be examined. Further links with IRAM will be developed as will analysis of data obtained from ALMA, Planck and ROSETTA. These are all good projects for the next five years.

The interesting new work may be threatened through an anticipated significant drop in funding, particularly through the loss of CNES support, which was (and still is) quite significant for exploiting the Herschel mission, but will be reduced as this mission is now over. The proposal to bid for funds from sources such as ERC and H2020 will be essential to attempt to mitigate these threats. Furthermore, known retirements need to be anticipated or the group could have a reduction in size of one third and key expertise will be lost. This could make the critical mass of the team too small to be viable and it may not then be possible to complete the promising research program that is proposed.

Short appreciation on this criterion

The team strategy is good and ambitious. Finding new resources to fulfil the objectives will be essential.

Conclusion

- Strengths and opportunities:

The team is very active from a scientific point of view. The combination of theoreticians and observers enables a direct confrontation of theoretical calculations with observations. The availability of facilities such as NOEMA, ALMA and JWST offers an opportunity for new observation programs.

- Weaknesses and threats:

Funding by CNES will be reduced on the medium term, as the Herschel mission is now over.

- Recommendations:

The team deserves a better recognition overseas, and is encouraged to work actively to develop its visibility (see above). Applications to EC funding schemes such as ERC and Marie-Curie fellowships are encouraged. Finally, the team, as other IPAG teams, should continue developing its relations with IRAM.

Team 2: CRISTAL

Name of team leader: Mr David MOUILLET

Workforce

Team workforce	Number as at 30/06/2014	Number as at 01/01/2016
N1: Permanent professors and similar positions	6	5
N2: Permanent EPST or EPIC researchers and similar positions	2	1
N3: Other permanent staff (without research duties)	2	2
N4: Other professors (PREM, ECC, etc.)		
N5: Other researchers (DREM, Postdoctoral students, visitors, etc.)	1.5	0.5
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**11.5**	**8.5**

Team workforce	Number as at 30/06/2014	Number as at 01/01/2016
Doctoral students	4	
Theses defended	6	
Postdoctoral students having spent at least 12 months in the unit		
Number of Research Supervisor Qualifications (HDR) taken	0.5	
Qualified research supervisors (with an HDR) or similar positions	6.5	5.5

Detailed assessments

Assessment of scientific quality and outputs

The originality of the CRISTAL team is to concentrate into a single scientific team most of the laboratory instrumental research and development and associated projects. It is a unique place where instrumentalists (both researchers and engineers) can gather, discuss, exchange and drive instrumental activities at all levels: system analysis, sub-systems design, research and developments, education, and valorisation (spin-off). This structure led to an international leadership in several fields such as on-board radar techniques (CONSERT on ROSETTA / PHILAE), high contrast imaging (development of SPHERE on the VLT, R&D FFREE for the E-ELT), interferometry using integrated

optics beam combiners (PIONIER, beam combiner of GRAVITY on the VLTI), fast NIR detectors (RAPID project). With 90 refereed papers and more than 220 proceedings papers, the CRISTAL team is one of the most publishing instrumental teams in France. The know-how developed in the above mentioned fields makes the laboratory a key partner of ESO in the development of the VLTI.

Short appreciation on this criterion

The quality of the instrumental developments made by the CRISTAL team is excellent, and makes the team one of the leaders of their activities in the world.

Assessment of the team's academic reputation and appeal

The international reputation of the CRISTAL team is excellent, and fed by their numerous successes in terms of instrument buildings and developments (SPHERE on the VLT, PIONIER on the VLTI, CONSERT on PHILAE…). Their know-how is recognized by regular invitations to international conferences, and publications in the best journals majored in instrumentation. Academically speaking, the team is attractive for PhD students (8 students in the last 5 years), and post-doctoral researchers (2 persons). The team is also included into local and national networks of laboratories majored in specific developments: *e.g.,* the FOCUS LabEx (IPAG, CEA, CEA/LETI) created to federate the efforts towards innovative detectors, JMMC (Jean-Marie Mariotti Centre) majored in the development of software for interferometers and interferometry observations.

Short appreciation on this criterion

The academic reputation of the team is excellent, at the level of their instrumental products.

Assessment of the team's interaction with the social, economic and cultural environment

The interaction of CRISTAL with its non-academic environment is certainly one of the most important characteristics of the team. The team is the starting point of 3 spin-offs: ALPAO (Adaptive Optics devices), First Light Imaging (FLI: created in 2012 to develop fast, low noise IR cameras for wave front sensing), and Resolution Spectra Systems (RSS: created in 2011 to commercialize integrated optics-based spectrometers). In every case, the creations of these spin-offs has been made possible by a technology transfer directly from the laboratory, and is still made easier by the direct participation of IPAG members in the partnership. On that purpose, the existence of strong LabEx devoted to instrumental development is a real force. The team is regularly requested to participate to social events (public observations, exhibitions…).

Short appreciation on this criterion

The involvement of the CRISTAL team in the social and economic environments is rather unique at this level in a French astrophysics laboratory and makes it a real pioneer.

Assessment of the team's organisation and life

As mentioned before, the team organisation is original, because each member of the team (either researcher or engineer) is also at 50 % a member of another scientific or technical team. More than a classical team, CRISTAL is a transverse axis gathering the instrumental concerns of the scientific teams, in order to share the methods, the techniques, the know-how and drive the instrumental developments and associated R&D. This allows the team to appear as a complete group when applying for project responsibilities or for funding. The decision to orientate the activities of the team towards specific directions is taken directly at the team level, in agreement with the laboratory management. The intimate mixture of project developments, R&D, spin-off makes the CRISTAL team a very specific place for instrumental development. This structure, which may appear as artificial and disconnected to other teams of the research unit, is in fact the way CRISTAL members answer the question of driving the instrumental developments of the laboratory with the required connection to the scientific questions.

Short appreciation on this criterion

The organisation of the team, and the fact that each member belongs to another team, makes the structure very light and easy to use. It also enhances the crosstalk between research and instrumental development, which remains decided at IPAG management level.

Assessment of the team's involvement in training through research

The CRISTAL team members are also strongly involved in teaching activities. Several members of CRISTAL are (assistant) professors or have similar positions. The team is strongly involved in the teaching activities of the University, mainly in the fields of physics and instrumentation. In addition, the team is also at the origin of specific training programs in the field of detectors thanks to the FOCUS LabEx. The team has been asked to participate to the creation, at the university level, of a "space centre", an academic structure devoted to the teaching of space sciences and techniques thanks to development of small scientific satellites ("cube sat"). The level of PhD prepared in the team is good: 8 PhD (about 1PhD/researcher over the 5 year period).

Short appreciation on this criterion

The involvement in training through research at the university level is effective.

Assessment of the strategy and the five-year plan

The CRISTAL strategy and the five-year plan are mainly built to increase the leadership of the team where it is a leader, *i.e.*, in the field of high angular resolution (from integrated optics devices to operational systems such as SPHERE or PIONIER), of on-board radar for planetary *in situ* exploration (CONSERT heritage, RIME on Juice), and of spectral imaging thanks to the development of specific detectors and integrated optics spectrometers.

After a period of system buildings and developments in the last 5 years, the next five years will offer the opportunity of more prospective works, in the context of the E-ELT roadmap towards extreme AO systems (PFS instrument), radar tomography for asteroids (prospective driven by CNES), VLT and VLTI 3rd generation of instruments and future interferometric arrays (PFI). The level of R&D developments, which have been maintained during strong instrumental implication phases (*e.g.*, SPHERE development), will be a strong help to estimate the maturity of the proposed concepts and drive the prospective process. This prospective phase is mandatory to help the team to be involved in the next generation projects. The committee recommends it be formalized in the form of a roadmap.

The committee also noted the different nature of the CRISTAL team, as compared with the other teams at IPAG. This could be explicitly recognized in the management structure of IPAG (see section 3 above).

Short appreciation on this criterion

The strategy and the five-year plan appear to be fully adapted to a post-big-projects phase where the team has to investigate new horizons to prepare its future involvements.

Conclusion

- Strengths and opportunities

The CRISTAL team is an efficient framework to address the instrumental concerns of the IPAG research teams. It has shown its efficiency by the completion or driving of both complex system development activities within international consortia (SPHERE, GRAVITY, PIONIER) and R&D activities (integrated optics beam combiners, spectrometers…). These R&D activities allow one to consider an active participation to future projects of the community (E-ELT, Radar tomography…). The link with spin-off is a real opportunity to increase the value of the instrumental developments performed in the laboratory. The implication in networks (LabEx FOCUS, JMMC) is a unique opportunity to participate in costly developments and to acquire a leadership in specific fields.

- Weaknesses and threats

The next decade should be considered seriously because of the important number of potential projects, their costs, and the social economic context that strongly limits the number of projects that will effectively be implemented. The evaporation of know-how because of departure of manpower to spin-off can be a limit to the technical development of the laboratory.

- Recommendations

The committee strongly recommends the CRISTAL team to be proactive in the foreseeing process concerning the future of high contrast imaging for the E-ELT and interferometry instruments, in order to drive the developments, instead of going step-by-step through the definition process of the future facilities. The decision to enter a new project or not should also be considered under the angle of available manpower. The committee also recommends to increase the value of instrumental developments and transfers to spin-off through the management of patents which can be a potential source of proper funding for the laboratory or its staff members.

Team 3: FOST (→ ODYSSEY and EXOPLANETES : Project)

Name of team leader: Mr Hervé BEUST

Workforce

Team workforce	Number as at 30/06/2014	Number as at 01/01/2016
N1: Permanent professors and similar positions	13	O*: 5.5 E*: 7.5
N2: Permanent EPST or EPIC researchers and similar positions	6	O: 3 E: 4.5
N3: Other permanent staff (without research duties)		
N4: Other professors (PREM, ECC, etc.)		
N5: Other researchers (DREM, Postdoctoral students, visitors, etc.)	8	O: 2 E: 1
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**27**	**O: 10.5 E: 13**

*The team FOST will split into two new teams: Odyssey (O) and Exoplanetes (E). They will be discussed separately in the strategy and 5-year plan section.

Team workforce	Number as at 30/06/2014	Number as at 01/01/2016
Doctoral students	13	
Theses defended	3	
Postdoctoral students having spent at least 12 months in the unit	2	
Number of Research Supervisor Qualifications (HDR) taken	0.5	
Qualified research supervisors (with an HDR) or similar positions	9	O: 3.5 E: 8

•Detailed assessments

Assessment of scientific quality and outputs

The team has the leadership at both national and international levels in several key projects concerning the observational studies of the evolution of the angular momentum of young stars and the empirical determination of the stellar IMF down to planetary masses; multi-wavelength high-resolution observations and modelling of protoplanetary disks; the detection and characterization of super-Earths in the habitable zone; the detection of planetary companions and exoplanets via direct imaging. The link instruments → observations → models is clear. In the last ten

years they achieved several "premières": first image of an exoplanetary system (2MASS 1207), first image of Beta Pic b, thanks to their unique experience in high dynamics instrument building and operation (through the CRISTAL team, cf. corresponding section in this report). Outstanding results have also been obtained with ALMA. The peculiarity of the team is the exploitation of all the high-angular resolution techniques (adaptive optics, coronography, interferometry, observation from space) to explore the environment of stars. It is a big team (24 permanent staff), with a lot of interactions/collaborations that has resulted in an impressive number of publications (more than 430 refereed publications in 5 years). Team members have received a remarkable number of honours, awards, and prizes in recognition of their excellent activity.

Short appreciation on this criterion

The team displays an excellent level of scientific activity, with several breakthrough results both in research on young stars and circumstellar disks, and in the search and characterization of exoplanets. Important progress has been made in a highly competitive field. The group has strong international visibility and recognition.

Assessment of the team's academic reputation and appeal

The academic reputation of the team is excellent, thanks to the impressive results of these last years. The prominence of the laboratory is strongly driven by the work of the FOST team, particularly in the fields of stellar evolution, young objects and exoplanets, and in the involvement in the design and operation of big instruments for the VLT and VLTI (SPHERE, PIONIER), and soon SPIRou at the CFHT. The activity has been recognized through several competitive grants (6 ANR, 1 junior ERC) and honours. The appeal of the team is strong: 14 PhDs have been defended in the last five years. A member of the team is Editor in Chief of A&A, which is a big involvement in the life of the community.

Short appreciation on this criterion

The team is well known internationally for its capacity to carry to fruition the development of front-line instrumentation in their key areas of research. The recruited scientific staff is of very high quality; the attractiveness of post-doctoral fellows is still to be improved.

Assessment of the team's interaction with the social, economic and cultural environment

Because of the structure of the scientific areas within the laboratory, where all the research activities related to instrumentation and technical development are gathered in a single team (the CRISTAL team, cf. corresponding section in this report), the links of the FOST team to the socio-economic environment are mainly limited to knowledge dissemination. This interaction covers many aspects: press releases through the Observatory structure (OSUG), direct contact with journalists, interviews, or TV broadcasts, participation in social events (public observations, conferences,…), and participation in the teaching activities of the University. In this sense, the team is very active.

Short appreciation on this criterion

Thanks to the extreme appeal of the research themes carried out within FOST on the general public, the team has established strong ties with the social and cultural environment through the dissemination of their results and discoveries.

Assessment of the team's organisation and life

The FOST team is the biggest of the Institute (24 permanent staff, 13 PhDs or post-doctoral researchers). This super-critical mass allows strong interactions between researchers and a multi-angle approach (both theoretical and observational) to the scientific questions/problems. In addition, 9 permanent staff members are involved in instrumentation development within the CRISTAL team, thus allowing FOST researchers to be leaders or high-level partners in several key projects (SPHERE, GRAVITY, PIONIER, HARPS, SOPHIE, …). In the field of extrasolar planets, FOST (and now EXOPLANETES) is certainly the biggest team in France dedicated to this topic. The strong interaction between stellar formation and evolution and stellar environment represents a truly remarkable strength of the team.

As a result of the emergence of new themes and innovative projects, the decision to split the FOST group into two separate smaller groups (Odyssey and Exoplanets) has been made with the goal of improving the organisational

efficiency and the quality of communication within the team. This split will still allow the members to have access to common resources, including office spaces.

Short appreciation on this criterion

The team has demonstrated a strong and coherent organisation aimed at maintaining the highest scientific profile in a period of important growth, both qualitative and quantitative.

Assessment of the team's involvement in training through research

The team has been consistently involved in training students, supervising 14 PhD's in the five year term of evaluation. It is also deeply involved in teaching at the University level. Several members of the team, also belonging to the CRISTAL team, are involved in the project of "space centre, a UJF initiative to teach space sciences and techniques through the conception, design, building, and operation of small satellites" ("cube sat"). Recently, the team was at the origin of one of the first MOOCs in astrophysics at UJF.

Short appreciation on this criterion

The ratio of PhD students to staff researchers (about 0.5) is adequate, but could be improved considering the attractiveness of the research areas of the team and the excellent quality of the research.

Assessment of the strategy and the five-year plan

The original strategy of the FOST team can be summarized as "From stars to planets" and has been extremely successful in obtaining first class results in the study of young stars and their protoplanetary disks and of new exoplanetary systems. Maintaining the link between these two aspects is a goal of the five-year plan, even though, as a result of the split in two groups, each team has developed its own coherent plan with the potential loss of a common vision. The strategy of the Odyssey and Exoplanetes teams is focused on the maximal exploitation of new instrumentation that is about to become available, including that developed locally (*e.g.*, SPHERE, GRAVITY, SPIRou, ExTrA).

Short appreciation on this criterion

The strategy developed by the FOST team guarantees to achieve fundamental progress in the field. In all of these developments the team members have or will have high-level responsibility.

Conclusion

- Strengths and opportunities

Over the years, the FOST team has developed an extremely strong and successful link between instrumentation, observations and modelling. This approach has allowed them to obtain important results in a variety of research areas and some truly remarkable breakthroughs in the field of high angular resolution observations of circumstellar disks and imaging of exoplanetary systems that have met with worldwide recognition and leadership. Of particular notice is the multi-wavelength approach to fully characterize all aspects of the astrophysical sources of interest, often using a variety of techniques developed in-house. The team has a large and solid network of collaborations within IPAG, and also at the national and international levels with a very positive impact on its efficiency and visibility. In the next five-year period the team is in the ideal position to conduct world-leading programs with the new generation instruments, such as SPHERE (VLT/ESO) and SPIRou (CFHT) to study the presence and properties of exoplanets around A-F type stars, young stars in nearby associations and around M-type dwarfs, as well as the dynamics of the accretion/ejection phenomenon in star/disk systems and the origin of the magnetic field in young stars. The latter research benefits tremendously from the use of sub-millimetre interferometers such as NOEMA and ALMA which are already routinely used by the team and which will allow even further progress with the various upgrades foreseen in the coming years. The team has been successful in obtaining a remarkable number of research grants from the ANR and, to a lesser level, from other local/regional agencies or partnerships. The recent split into two independent groups, Odyssey and Exoplanets, should be viewed as an opportunity for growth as each team is well beyond the critical mass and can more coherently pursue its own scientific priorities and obtain even more visibility at all levels.

- Weaknesses and threats

The future five-year plan, although well structured and planned, is very ambitious for both teams considering the reduced amount of resources, both human and financial, that the Institute has experienced in the past few years. If the economic difficulties persist, some programs and objectives should be reconsidered as they may not be essential for the success of the project (for example, the activity of the Exoplanetes group on the characterization of the exoplanet host stars appears to be of less visibility/impact than the detection and characterization of planets and planetary systems in which they excel. This threat may be more pronounced for the Odyssey team that is now smaller in size and has some members on extended leave of absence. A weakness of the two teams is the small number of grants at the European level that has been obtained in the past in spite of the very high level of the research carried out both by individual researchers (at the consolidator and senior levels) and by the team.

- Recommendations

A particular effort should be made so as to avoid a break of the link "From stars to planets" that has been so successful until now. The two new teams should maintain strong links with each other, as this has been an asset in the past. It is recommended that the ODYSSEY team should reinforce its collaborations within IPAG, particularly with SHERPAS for the modelling efforts. Similarly, the EXOPLANETES team should consider the possibility to create more efficient links with the PLANETO team. The attractiveness of the teams at the international level should be improved by fostering programs for invited visitors and the organisation of international conferences. The current situation of a limited number of ERC grants should be definitely improved with a more pro-active participation in the regular calls of the ERC. The team has clearly the potential to host an "ERC advanced" grant. The two teams should pursue a more aggressive policy of recruiting PhD students in order to reduce the ratio between staff members and students. The number of post-doctoral fellows is too small compared to the size of the teams and should increase.

Team 4: PLANETO

Name of team leader: Mr Roland THISSEN

Workforce

Team workforce	Number as at 30/06/2014	Number as at 01/01/2016
N1: Permanent professors and similar positions	6	6
N2: Permanent EPST or EPIC researchers and similar positions	6	5
N3: Other permanent staff (without research duties)	2	
N4: Other professors (PREM, ECC, etc.)		
N5: Other researchers (DREM, Postdoctoral students, visitors, etc.)	1.5	0.5
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**15.5**	**11.5**

Team workforce	Number as at 30/06/2014	Number as at 01/01/2016
Doctoral students	6	
Theses defended	11	
Postdoctoral students having spent at least 12 months in the unit		
Number of Research Supervisor Qualifications (HDR) taken	4	
Qualified research supervisors (with an HDR) or similar positions	9	8

•Detailed assessments

Assessment of scientific quality and outputs

This interdisciplinary team develops three main research axes: (1) the study of the asteroids, comets and planetary (especially Mars) surfaces, (2) atmospheric and auroral physics on *Earth and space weather, (3) astrochemistry of meteorites and upper atmospheres (Titan and Mars mainly)*. They are among the leading teams in France on these subjects.

With the passing years, they have gained a huge experience in radar for solid-body sounding, analysis of hyperspectral images, analytical experiments in laboratories and numerical modelling of atmospheric chemistry (radiative transfer and kinetic codes).

Their expertise on radar space exploration of the (sub)surface of the solid bodies is unique in France and well recognized at the international level. This enabled them to become PI for the CONSERT experiment on board of the PHILAE lander of the ROSETTA mission, an instrument that was highly solicited for selecting the landing site, despite the fact that the team did not have much hardware contribution to the instrument.

The other speciality of the team is the analysis of extra-terrestrial material in the laboratory. The analysis of asteroid grains from the Hayabusa mission leads to very interesting, new results on the reflectance of the body. The team also developed a very innovative experiment to follow in the laboratory the evolution of CO_2 ice under Martian atmospheric conditions. Team members involved in this activity are among the leaders of the analysis of organic materials of interest for astrochemistry with high-resolution mass spectrometry.

Space weather is also an important activity for the team which is especially active and recognized for its work on polarization in auroral emissions, and for the study of auroras of Earth and other (exo)planets with observations from space platforms. The team has published 158 papers in prominent journals, including standard astronomy journals but also Icarus, Geophys. Res. Lett., Geochys. Cosmochim. Ac., etc., and team members were invited to give 14 specific talks in international congresses. This is a very satisfying level of activity, especially since half of the group is deeply involved in teaching duties at the University.

Short appreciation on this criterion

The quality of the research performed in the group is excellent and at an international level.

Assessment of the team's academic reputation and appeal

The team reputation relies on its unique expertise in various fields. It is evidenced for example by the fact that the team co-led a European network (COST action "Polarization as a tool to study the Solar System and beyond") and participated to three others (VAMDC, Europlanet and ATMOP); it also (co)organized several large attendance international congresses as well as schools and specific sessions in major international conferences. As mentioned above, the team has gained the PIship of the CONSERT experiment on board the ROSETTA mission, and several team members belong to the scientific groups of the JUICE (a mission to study Jupiter icy moons) and ExoMars space missions.

One should also note that one member of the team has created a space weather journal and is currently chief editor. The first papers were published in 2011 and the journal already has an h-impact factor of 2.5. Another team member is associate editor of an international journal on chemistry applied to geophysics and planetary science (h-factor of 4). Finally, a team member received the Nier Prize, which recognizes outstanding research in meteoritics by young scientists. The UJF also provided to this group a chair of excellence.

Among the 17 PhD students considered during the period 2009-2013, only 6 are coming from local Masters, which demonstrates the large attractiveness of the team.

Short appreciation on this criterion

This team's academic reputation and appeal is very good.

Assessment of the team's interaction with the social, economic and cultural environment

The CRISTAL and PLANETO teams are developing very innovative R&D in micro-spectrometers, miniature spectro-imager and data treatment for high resolution mass spectroscopy, in tight collaboration with other laboratories. The objective is to equip the future space missions but these developments can also be used in other fields than astronomy. The R&D on micro-spectrometers is very appealing and promising. It should lead to further patents and strengthen links with Grenoble industrial partners. To preserve a high level return to the laboratory, the astrophysical goals should be more clearly identified.

The team is also deeply involved in Public Outreach activities. It developed "The Planeterrella", a very successful instrument to explain science and in particular the auroral physics to a large public. It has been awarded several prizes: in 2010 it received the first prize of the Europlanet network for public outreach activities, and in 2012 the « gout des sciences prize », a prize awarded by the Science ministry. Plans to build the instrument being free, the instrument is now present in numerous institutes worldwide.

Short appreciation on this criterion

The R&D developments are very promising. The team is deeply involved in public outreach activities, and the impact goes far beyond the regional level.

Assessment of the team's organisation and life

The team is an interdisciplinary team studying various objects and environments in the solar system, but its activities are focused on space exploration and on the interpretation of data collected by space instruments, either partly developed at IPAG (*e.g.,* CONSERT) or built in other laboratories (*e.g.,* VIRTIS). This ensures the coherence and strength of the team.

The team, as other IPAG teams, does not receive a specific budget; the overheads from the team contracts are redistributed according to the needs of its members. This organization appears to work to everybody's satisfaction, at least as long as the contracts are sufficient.

Premises are today well suited to the team activities after years of work on the building, especially concerning experimental and instrumental activities. It is crucial that the experimental facilities not be affected by possible reorganisations of IPAG that would be helpful to consolidate the merge process of LPG and LAOG (see section 3).

Collaboration inside IPAG started as soon as the laboratory was created, and eased the integration of LPG (today the PLANETO team) within IPAG. Collaborations with other laboratories in the framework of the OSUG, as well as at the national and international level, are well developed and provide them with a good visibility.

Short appreciation on this criterion

The team organization is good, and well adapted to the needs.

Assessment of the team's involvement in training through research

With 11 PhD students having defended their thesis and 6 theses in progress, the ratio of PhD students to potential supervisors appears to be good.

In addition to standard teaching activities, it should be noted that team members have a very significant contribution to teaching management, in particular at Master level (direction of Master A2P).

Because of its past experience in space instrumentation, the team is strongly involved in the development of the space campus project aiming at training students from various levels (Licence, Master, and Engineering).

Short appreciation on this criterion

The involvement in training through research is very good.

Assessment of the strategy and the five-year plan

The five years project capitalizes on the previous developments done in the team. It aims at deepening the knowledge on the formation of the solar system and the planetary evolution. The team is involved at the scientific level and, to some extent, at technical level in the future major international space missions tackling these subjects. One of the main originalities is the analysis of cosmo-material in the laboratory, and the production of spectral data required to analyse and interpret data acquired by space probe instruments. This speciality will be even improved with the building of a dedicated clean room, and of a new spectroscopic facility that will be widely open to teams from all over the world. Also, the spectroscopic database GhoSST, developed for the benefit of the whole international community, has started distributing spectroscopic data in 2012.

Short appreciation on this criterion

The project is very coherent and well focused.

Conclusion

- Strengths and opportunities

The PLANETO team is a group of high scientific level, well recognized both nationally and internationally for its different activities, most of them being connected to space missions. Outreach activities are very significant and visible.

- Weaknesses and threats

Some of the PLANETO activities, and notably some of the most prominent ones (*e.g.*, magnetospheres and space weather, and, to a lesser extent, radar) rely on very few individuals. Departures, either due to retirements or to the end of temporary contracts, would endanger them. On the long term, the ability of the team to be PI (or CoPI) of instruments on board of space missions without any hardware contribution is questionable, as the institutes building these equipments might be willing to acquire the scientific know-how.

- Recommendations

The team is encouraged to develop a plan assessing the priorities of the various activities, their possible evolutions, and the recruitment needs, taking into account the current perspectives for hiring new personnel on permanent positions. The committee also encourages the team to continue developing projects with other IPAG teams, and in particular with the exoplanet group.

Team 5: SHERPAS

Name of team leader: Mr Gilles HENRI

Workforce

Team workforce	Number as at 30/06/2014	Number as at 01/01/2016
N1: Permanent professors and similar positions	2	2
N2: Permanent EPST or EPIC researchers and similar positions	5	5
N3: Other permanent staff (without research duties)		
N4: Other professors (PREM, ECC, etc.)	2	2
N5: Other researchers (DREM, Postdoctoral students, visitors, etc.)	1	
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**10**	**9**

Team workforce	Number as at 30/06/2014	Number as at 01/01/2016
Doctoral students	2	
Theses defended	3	
Postdoctoral students having spent at least 12 months in the unit		
Number of Research Supervisor Qualifications (HDR) taken	1	
Qualified research supervisors (with an HDR) or similar positions	5	5

•Detailed assessments

Assessment of scientific quality and outputs

The substantial scientific output of the SHERPAS team covers several different fields, mirroring the wide range of expertise present in this team. Significant original contributions have been made to the theory of particle acceleration at relativistic shocks and to the development of numerical and analytical models of accretion disks, jets and winds. Members of the team have played a crucial role in X-ray and multi-wavelength observations of active galactic nuclei, and in observations of high energy (GeV) and very high-energy (TeV) gamma rays from binary systems.

This is, in general, high quality work, and in two areas the results are particularly impressive: (i) Ground-breaking work performed by members of the group over the last few years has led to the emergence of a new class of

object, the "gamma-ray binaries", with remarkable properties that challenge current models. (ii) Important new questions have recently been raised concerning the theory of proto-stellar and proto-planetary disks by work that has highlighted the role of non-ideal MHD effects. This work has the potential to initiate a paradigmatic change.

These and other discoveries have been published in leading, peer reviewed international journals. Particularly high impact has been achieved by two publications in "Science" in each of which a team member was a corresponding author, and by a major review paper in Astronomy and Astrophysics Reviews.

The group plays an important role in the H.E.S.S. collaboration, providing five individual members, one of whom was the convener of the working group on extra-galactic sources during part of the review period. It has contributed to the CTA collaboration in both the science working groups and in developing light concentrators for the future telescopes.

Short appreciation on this criterion

This is a productive team that works on a wide range of topics. Its output is substantial. Overall it is of high quality, and achieves excellence in some areas.

Assessment of the team's academic reputation and appeal

The group demonstrates leadership at the international and national levels by having provided the convener of the extra-galactic working group within the H.E.S.S. collaboration and by providing the current Director of the CNRS/CNES/CEA High Energy Program (PNHE). It has hosted a Marie-Curie reintegration grant, and, crucially, an ERC starting grant that substantially enhanced the team's international visibility. Nevertheless, given the high quality of the results obtained, the committee felt that an increase of the team's visibility should be possible, in particular in the U.S., and recommends that the team concentrate more resources on presenting its work at major international conferences.

Short appreciation on this criterion

The team reputation is very good, and could even be improved.

Assessment of the team's interaction with the social, economic and cultural environment

The team contributes actively to this topic, which is assessed at the institute level.

Assessment of the team's organisation and life

Despite diverse research interests, the SHERPAS team has a strong sense of identity. This is based on a common interest in theoretical astrophysics, in particular fundamental processes and numerical modelling. It is cultivated by regular weekly meetings and, historically, by a long tradition of annual retreats. Communication between all team members appears to be very good. The aspects of this criterion that concern access to common ressources, support for new projects, representation on the Institute council, communication of scientific results and the adequacy of premises are assessed at the institute level.

Assessment of the team's involvement in training through research

Currently, two members of the SHERPAS team are active university professors who are deeply committed to teaching. They have directed the second year Master's program in astrophysics and the common first year program of all physics Master courses. The group also provides the deputy director of the physics department and the deputy to the vice-president for teaching of the University of Grenoble. Although the number of students is modest (currently three) compared to the number of scientists on permanent contracts (currently seven), the quality of the training at PhD level is very high. This is illustrated by the recent award of the prestigious Lyman Spitzer Fellowship at Princeton to a student who obtained a PhD in the group during the current review period.

Assessment of the strategy and the five-year plan

The team is clearly at a crucial point in its development. Retirement and the recent departure of a graduate student have deprived it of much of its expertise in plasma physics, which underpins the research on particle acceleration. In the medium term, continuation of this activity thus hinges on the recruitment of a suitable individual. On the other hand, the research activity on accretion disks and jets has recently been strengthened, and the team is proposing consistent and exciting projects in this area, which will involve closer ties to the ODYSSEY team.

Modelling and observations of the X-ray and gamma-ray emission of binaries and AGNs is also a field in which continuity is assured. The team proposes here to continue its activity in X-ray observation using the improved facilities that will become available in the next few years, and to continue to coordinate multi-wavelength campaigns. In parallel, it will strengthen its involvement in CTA, in particular by helping to define the science goals. Some of these projects will intensify collaborations recently initiated with the ASTROMOL team. They are realistic as they build on demonstrated know-how and use resources which are either available locally, or can reasonably be expected to be awarded in open competition. Nevertheless, a degree of risk is present.

The involvement in hardware development for CTA is currently at a modest level. This may be positively influenced by the plans for a "University Grenoble Alpes" which would bring in laboratories in Annecy with relevant expertise, but the impact on activities in IPAG is at present unclear.

The activity on the classification of astrophysical objects is unique. Currently, its impact and visibility is limited. Its potential is uncertain, so that it must be regarded as a high risk project, whose growth will depend upon the acquisition of external funding. However, given the limited internal resources it requires, its continuation at the current level appears realistic.

The committee was informed of projects to merge this team with the newly created team, ODYSSEY, with which interactions are and should be important. This is an ongoing process that had barely started when the committee visited IPAG; the committee was therefore unable to fully appreciate the implications of this evolution, which, taking into account the small size of the SHERPAS team, appears to be a natural consequence of the desire to strengthen the teams and to reduce their number (see the discussion in Sect. 3).

Short appreciation on this criterion

Some degree of re-orientation of the team appears essential and promising future collaborative projects are emerging. However, there is a risk that some projects may suffer from lack of resources.

Conclusion

- Strengths and opportunities

The team benefits from the high scientific value of its members. In the near future, projects such as Gravity will bring important data on AGNs; on the longer term, CTA (and Athena on the much longer term) provide opportunities for new developments.

- Weaknesses and threats

The team is small and departures, if not compensated, will result in a loss of expertise in the plasma physics domain. The participation in CTA still needs consolidation.

- Recommendations

The research unit management should pay careful attention to this group and its coherence in any restructuring plan. The team should make a concentrated effort on recruitment at both senior level (via national programs) and junior level (via European programs).

5 • Conduct of the visit

Visit dates

Start:	Monday 12 January 2015 at 08: 30
End:	Wednesday 14 January 2015 at 14:00

Visit sites:	3 buildings hosting IPAG staff, located on Saint-Martin d'Hères campus
Institution:	Université Joseph-Fourier
Address:	414, Rue de la Piscine, Domaine Universitaire, 38400 St-Martin d'Hères.
Postal address:	BP 53F-38041 GRENOBLE Cédex 9

Specific premises visited:

Monday 12-13h

- Ground projects : OSUG-A
  - GRAVITY integration
  - BETI/RAPID: development of state of art infrared detector on interferometric bench
- Space projects: OSUG-B
  - SWIFTS/SPOC: miniaturized spectrometry for space imaging spectrometry
  - NEAT: sub-pixel detector characterisation for astrometry

Tuesday 14-15h

- Ground based projects: OSUG-B
  - FFREE Bench: high contrast imaging & IPAG Adaptive Optics instrumentation.
- Space projects: PhyTEM-D
  - Planetology labs

Conduct or programme of the visit:

Monday12 January 2015

08:30 - 08:45	Welcome
08:45 - 09:20	Closed session
09:30 - 09:40	Introduction to the visit by the HCERES delegate
09:40 - 10:35	Laboratory activity report by IPAG Director and discussion
10:35 - 10:50	Coffee break
10:50 - 11:15	Organization and management of the technical group by IPAG technical director; discussion; introduction to technical visits
11:15 - 12:00	Strategic and scientific perspectives by IPAG future director
12:00 - 13:00	Site visit OSUG-A / CERMO (two parallel subgroups)

13:00 - 14:00	Lunch
14:00 - 16:30	Scientific reports of each team
14:00 - 14:45	Achievements / Prospective ASTROMOL
14:45 - 15:30	Achievements / Prospective CRISTAL
15:30 - 16:15	Achievements / Prospective SHERPAS
16:15 - 16:30	Coffee break
16:30 - 17:00	Meeting of committee members with Astromol & Cristal teams (parallel)
17:00 - 17:30	Meeting of committee members with SHERPAS team
18:00 - 19:00	Closed session

Tuesday 13 January 2015

08:30 - 08:55	Closed session
09:00 - 09:45	Achievements / Prospective PLANETO
09:45 - 10:55	Achievements / Prospective FOST / ODYSSEY & EXOPLANETS
11:00 - 11:15	Coffee break
11:15 - 11:55	Parallel meetings of committee members with Planeto & FOST/ODYSSEY & EXOPLANETS)
11:55 - 12:25	Activity report of the Administration network services
12:30 - 13:00	Prospects for the technical activity (technical director) – Introduction to site visits
13:00 - 14:00	Lunch with team and service heads
14:15 - 15:20	Site visits of CERMO–D/OSUG-A (parallel)
15:30 - 16:00	Closed session with research staff
16:00 - 17:00	Closed session with representative of the unit's supervising institutions
17:00 - 17:20	Closed session with heads of doctoral schools
17:20 - 17:50	Closed session with technical and administrative staff
17:50 - 18:20	Closed session with PhD students
18:20 - 18:50	Closed session with post-docs and temporary staff
18:50 - 19:30	Closed session

Wednesday 14 January 2015

08:30 - 08:55	Closed session
09:00 - 10:00	Closed session with current and future management team
10:00 - 12:30	Closed session
12:30 - 13:45	Lunch (closed)
14:00	End of the meeting

All sessions were opened to IPAG staff and IPAG supervising institutions except when otherwise noted. Closed sessions were restricted to committee members and HCERES delegate. The management team and team/services heads were excluded from closed sessions with IPAG staff.

6 • Supervising bodies' general comments

Université Joseph Fourier
GRENOBLE

DIRECTION POUR LA RECHERCHE ET LA VALORISATION

Affaire suivie par :
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Directrice

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BP53
38041 Grenoble
Cedex 9

Grenoble, le 13 avril 2015

Le Président de l'Université Joseph Fourier Grenoble 1

à

Monsieur le Professeur Jean-Marie HAMEURY,

Président du Comité de visite HCERES de l'Institut de Planétologie et d'Astrophysique de Grenoble (IPAG)

Objet : Visite HCERES – Institut de Planétologie et d'Astrophysique de Grenoble (IPAG)

Réf. : S2PUR160011222 - INSTITUT DE PLANETOLOGIE ET D'ASTROPHYSIQUE DE GRENOBLE - 0381838S

Monsieur,

Au nom de toutes les tutelles de l'Institut de Planétologie et d'Astrophysique de Grenoble, je tenais à remercier l'ensemble des membres du Comité de visite HCERES, dont vous êtes le Président, pour son travail d'analyse approfondie.

Vous trouverez, en pièce jointe, les commentaires que Monsieur le Professeur François-Xavier Désert, Directeur de l'unité, a tenu à apporter après avoir pris connaissance du rapport d'évaluation.

Je vous remercie pour le temps que vous avez bien voulu nous consacrer et vous prie d'agréer, Monsieur, l'expression de ma considération distinguée.

Le Président,

Patrick LEVY

Pour le Président,
Par délégation
Le Vice-président du Conseil Scientifique
de l 'Université Joseph Fourier - Grenoble 1
Yassine LAKHNECH

PJ : *CommentsAll_HCERES_IPAG_2015*

Copie : *Professeur Michel BLANC, Délégué scientifique représentant du HCERES*
Professeur François-Xavier DESERT, Directeur de l'IPAG

IPAG
Institut de Planétologie et d'Astrophysique de Grenoble

General Comments

on the HCERES 2015 report

To : the president of the HCERES committee

10 April 2015

Dear colleague,

The IPAG laboratory wishes to thank the committee for its visit to the laboratory and the thorough report about the laboratory. We share most of the analyses presented in the report and we welcome and agree on the prospective advice that are given.

One major disagreement point concerns the Astromol team international recognition. We think that the report phrasing is misleading (see the detailed comments). Also, the report does not reflect the diversity of the research activities pursued by this team.

Another omission in the report concerns the major IPAG involvement in Herschel scientific output, across the scientific teams.

Finally, the tables for the 2016 projections of numbers of PhD students, post-docs, etc.. may be misleading because of large uncertainties.

Best regards

François-Xavier Désert, IPAG director

Sherpa Team

"the current instrumental developments on light concentrators are currently not in the CTA baseline; given the importance of CTA, the interest of the SHERPAS team and its visibility in the HESS and CTA consortia, this issue should be sorted out in close interaction with INSU."

The light concentrators done at IPAG are completely part of the CTA development phase. Two concepts (Winston cones and lenses) had been developped and studied at IPAG during the CTA preparatory phase (PP). These concepts have been tested and validated at IRAP on a test bench partly designed by IPAG engineers. These developments have been partly supported by the CTA PP FP7 fundings. The Winston concept is the one that has been chosen for the NectarCam camera prototype that should be built in 2015-2016. It is also used in the FlashCam camera development and discussions with LSTCam engineers are ongoing. Estimation of the industrial manufacturing process for mass production (50 000 to 100 000 units) has also been done.

IPAG is actively participating to the preparation of the TGIR proposal prepared by CTA France and asking for funding for, among others, the production of 23 MST cameras. In this TGIS proposal, IPAG is clearly identified as responsible for the light concentrators development for the NectarCAM cameras.

Astromol Team (see the following page), Planeto Team (4 following pages)

We are surprised that **several major domains of activities of ASTROMOL are not mentioned in the HCERES report, which involve a large fraction (75 %) of the team members: instrumentation and observations.** As reported in the document provided to the panel (pg 11-12)

- there exist close links between ASTROMOL and the IRAM and ALMA observatories. An example is provided by the development of a new millimeter continuum camera for the IRAM 30m telescope, NIKA2 and [that will be] made available to the community in 2016. Our team is also involved in the commissioning of ALMA: calibration and long baseline campaign.
- most of the projects of the team are linked to the exploitation of observational Large Programs **led** by team members, in relation with cutting-edge instrumental facilities: Herschel/CHESS, IRAM/ASAI,IRAM/NIKA2. The scientific exploitation of these programs is based on international scale consortia, and involves longstanding collaborations with first rank institutes in Europe and worldwide.
- the preparation and exploitation of these programs relies on federative structures and collaborative projects (3 ANRs and 2 COST actions).

All these activities have gained the team a long-standing reputation at the highest international level, based on the following standard criteria and as reported in the document provided to the panel (pg 11-12)

- Team members serve or have served over the considered period **in many committees, at national and international levels:** ESA and CNES groups, ERC panels, Time Allocation Committees of World-leading facilities (Herschel, IRAM, ALMA), refereeing at European level (ERC), for National Science Agencies and Institutions in Europe and overseas (Czechia, Ireland, The Netherlands, Sweden, Taiwan, United Kingdom)
- **International collaborations:** co-PIship of COST Action "The Chemical Cosmos" (2010-2013), PIship of the current COST Action "Our Astrochemical Heritage" (2015-2018), Bilateral PHC collaborations (NH, China, Japan, Spain), sabbatical periods in world-leading institutes in Astrochemistry (CAB Spain, NOW NH, NASA USA)
- **International conferences and events:** more than 30 invitations over the period considered, PIship of one review chapter in Protostars and Planets VI (one of the only two chapters led by IPAG), Lectures in International Schools (IRAM, COSPAR, NASA Astrobiology, COST, Les Houches), one review chapter in Astronomy and Astrophysics Review (2012)
- **Prizes and Awards:** Médaille d'Argent du CNRS 2008, Prix Irène Joliot-Curie 2006, Prix Deslandes de l'Académie des Sciences 1996, Prize of the best French-Spanish Joint Scientific Project in Astronomy 2014 SF2A-SEA

PLANETO Team

Comments and suggestions on the preliminary report of HCERES

Grenoble, April 9 2015

General comments

1. The name of the team is PLANETO. The term "planetology" does not exist in English, we advice to use "Planetary Sciences".
2. LPG was created 12 years ago (not 10)
3. Our feeling is that activities devoted to Mars science are hardly mentioned in the manuscript. This is at odd with the involvement of the team and the high publication record (see publication list below).
4. PLANETO team had strong involvement in the hardware of the CONSERT instrument. This statement has been denied several times in the report (see below).

Focused comments

Comment number 1

- thesis in planetology whose duration (41 months on average, but this is small number statistics) exceeds the initially planned duration

We have calculated once again this number and found 38.

Comment number 2

-p24: "The team also developed a very innovative experiment to follow in the laboratory the evolution of the carbon dust grains **CO_2 ice** under Martian atmospheric conditions."

This experiment deals with CO2 ice (not carbon dust grains) and should not appear in a section devoted to the analysis of extraterrestrial material.

We suggest the following sentence, to be inserted after the section dedicated to :

The team also developed a very innovative experiment to follow in the laboratory the evolution of **CO_2 ice** under Martian atmospheric conditions.

Comment number 3

The GhoSST database has started to be fed since 2012 and has been distributing data since September 2012 to the whole community.

p25: "Also, the spectroscopic databases GhoSST, developed for the benefit of the whole international community and recognized by INSU as SNOs, has started distributing spectroscopic data in 2012. »

Comment number 4
There is a series of wrong statements on IPAG implication on hardware development on the CONSERT instrument onboard the ROSETTA spacecraft.

"The radar expertise at IPAG is unique, and this is the reason why, although IPAG did not contribute to any hardware, it could host the PI of the CONSERT instrument; this is a rather unique situation for instruments which are developed in consortia of academic laboratories. Page 7 § 3

This enabled them to become PI for the CONSERT experiment on board of the PHILAE lander of the ROSETTA mission, an instrument that was highly solicited for selecting the landing site, despite the fact that the team did not have any hardware contribution to the instrument. Page 24 § 1

On the long term, the ability of the team to be PI (or CoPI) of instruments on board of space missions without any hardware contribution is questionable, as the institutes building these equipments might be willing to acquire the scientific know-how. Page 26 § 2"

The statements concerning the hardware development in these three phrases are not factually correct. IPAG (previously Cephag and LPG) participated in the instrument design, in the electronic architecture definition and in the characterization of electronic components. IPAG was in charge of calibration and signal quality during the whole Consert experiment development. PI's group had daily contact with partner teams in LATMOS (electronics) and MPS (antenna), and participated actively in the work. The instrument calibrations were led by IPAG: procedures definition, ground calibrations during thermal vacuum tests and subsequent data analysis. In IPAG, an associate professor (MdC) worked on these tasks since 1999, and during the period 1995-2002 an engineer (CDD) was hired.

In 2001, LATMOS had started to disengage from the CONSERT project (4 departures for NOEMI in few months), and IPAG (LPG) insured half of the manpower for the integration of CONSERT into the spacecraft and for performing all relevant tests. After the launch of the ROSETTA spacecraft, IPAG took charge progressively the totality of operations.

The meaning of second cited sentence from HCERES report is not very easy to understand. The factual reason of IPAG involvement in the landing site selection is the fact that CONSERT has been operated during the Comet phase only by IPAG.

Annex: Mars publication record 2009-2014

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2. Grima, Cyril; Kofman, Wlodek; Mouginot, Jérémie; Phillips, Roger J.; Hérique, Alain; Biccari, Daniela; Seu, Roberto; Cutigni, Marco, 2009, North polar deposits

of Mars: Extreme purity of the water ice, Geophysical Research Letters , 36, 03203

3. Simon, C.; Witasse, O.; Leblanc, F.; Gronoff, G.; Bertaux, J.-L., 2009, *Dayglow on Mars: Kinetic modelling with SPICAM UV limb data*, Planetary and Space Science , 57, 1008

4. Nicholson, William P.; Gronoff, Guillaume; Lilensten, Jean; Aylward, Alan D.; Simon, Cyril, 2009, *A fast computation of the secondary ion production in the ionosphere of Mars*, Monthly Notices of the Royal Astronomical Society , 400, 369

5. Mouginot, J.; Kofman, W.; Safaeinili, A.; Grima, C.; Herique, A.; Plaut, J. J., 2009, *MARSIS surface reflectivity of the south residual cap of Mars*, Icarus , 201, 454

6. Schmidt, Frédéric; Douté, Sylvain; Schmitt, Bernard; Vincendon, Mathieu; Bibring, Jean- Pierre; Langevin, Yves; OMEGA Team, 2009, *Albedo control of seasonal South Polar cap recession on Mars*, Icarus , 200, 374

7. Mouginot, J.; Pommerol, A.; Kofman, W.; Beck, P.; Schmitt, B.; Herique, A.; Grima, C.; Safaeinili, A.; Plaut, J. J., 2010, *The 3-5 MHz global reflectivity map of Mars by MARSIS/Mars Express: Implications for the current inventory of subsurface H2O*, Icarus , 210, 612

8. Schmidt, F.; Schmitt, B.; Douté, S.; Forget, F.; Jian, J.-J.; Martin, P.; Langevin, Y. & Bibring, J.-P.Sublimation of the Martian CO2 Seasonal South Polar Cap *Planetary and Space Science,* **2010**, *58*, 1129 - 1138

9. Grima, Cyril; Costard, François; Kofman, Wlodek; Saint-Bézar, Bertrand; Servain, Anthony; Rémy, Frédérique; Mouginot, Jérémie; Herique, Alain; Seu, Roberto, 2011, *Large asymmetric polar scarps on Planum Australe, Mars: Characterization and evolution*, Icarus , 212, 96

10. Grima, Cyril; Kofman, Wlodek; Herique, Alain; Orosei, Roberto; Seu, Roberto, 2012, *Quantitative analysis of Mars surface radar reflectivity at 20 MHz*, Icarus , 220, 84

11. Madeleine J.-B., F. Forget, A. Spiga, M. Wolff, F. Montmessin, M. Vincendon, D. Jouglet, B. Gondet, J.-P. Bibring, Y. Langevin and B. Schmitt 2012. Aphelion water-ice cloud mapping and property retrieval using the OMEGA imaging spectrometer onboard Mars Express. J. Geophys.Res. E., 117, E00J07

12. Mendillo, Michael; Narvaez, Clara; Withers, Paul; Matta, Majd; Kofman, Wlodek; Mouginot, Jeremie, 2013, *Variability in ionospheric total electron content at Mars*, Planetary and Space Science , 86, 117

13. Garenne, A, G. Montes-Hernandez, P. Beck, B. Schmitt, O. Brissaud and A. Pommerol 2013. Gas-solid carbonation as a possible source of carbonates in cold planetary environments. Planetary & Space Sciences, 76, 28-41.

14. Marrero, R, S. Douté, A. Plaza and J. Chanussot 2013. Validation of spectral unmixing methods using photometry and topography information. Hyperspectral Image and Signal Processing: Evolution in Remote Sensing, IEEE 'WHISPERS 13', 1-4.

15. Pommerol, A., T. Appéré, G. Portyankina, K.-M. Aye, N. Thomas, C. J. Hansen 2013. Observations of the Northern seasonal polar cap on Mars III: CRISM / HiRISE observations of spring sublimation. Icarus, 225, 911-922.

16. Douté, S.; Ceamanos, X.; Appéré, T. 2013, Retrieving atmospheric dust opacity on Mars by imaging spectroscopy at large angles. Planetary and Space Science , 85, 38-52.

17. Ceamanos X., S. Douté, J. Fernando, F. Schmidt, P. Pinet, A. Lyapustin 2013. Surface reflectance of Mars observed by CRISM/MRO: 1. Multi-angle Approach for Retrieval of Surface Reflectance from CRISM observations (MARS-ReCO). J.Geophys.Res. Planets, 118, 514-533.

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19. El Goresy, Ahmed; Gillet, Ph.; Miyahara, M.; Ohtani, E.; Ozawa, S.; Beck, P.; Montagnac, G., 2013, *Shock-induced deformation of Shergottites: Shock-pressures and perturbations of magmatic ages on Mars*, Geochimica et Cosmochimica Acta , 101, 233

20. Pommerol, A., N. Thomas, B. Jost, P. Beck, C. Okubo, A. McEwen 2013. Photometric properties of Mars soil analogs. J.Geophys.Res. Planets., 118, 2045-2072

21. Massé, M., P. Beck, B. Schmitt, A. Pommerol, A. McEwen, V.F. Chevrier, O. Brissaud and A. Séjourné 2014. Spectroscopy and detectability of liquid brines on Mars. Planetary & Space Sciences, 92, 136-149.

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