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Star Formation at Infrared Wavelengths

Infrared detectors and imaging surveys

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Ground based Imaging in the infrared : where do we start from ?
- the atmosphere is "uniformly" transparent from 0.3μm to 1μm.
- A set of filters has been (freely) designed (U, B, V, R, I, z)
- large detectors exist
- Use of spatial facilities (HST) more for the UV than for the visible.

Ground based Imaging in the infrared : where do we go ?
- The atmosphere has transparent windows up to 20 microns, with significant opaque gaps.
- One is not free to choose the filters outside of the transparent windows
- The atmosphere begins to "glow".
- upward 300μm, there is no infrared anymore but sub-millimeter.

Spatial imaging in the infrared : what do we have ?
- IRAS and ISO
- Spitzer
- Herschell

As its name tells it, the infrared domain begins where the red (hence the visible) ends. This can be checked on the atmosphere transmission curve, where the transparent domain extends far further out the visible.

IR imaging detectors use various technologies.
If one defines IR

Define what is 'infrared' (from Mark lecture).
Define what is 'imaging' (when the properties of detectors get larger than the mere sum of many pixels together).
Note that most of the time, people design instruments to perform "at the same time" spectroscopy and imaging : VISIR, ISAAC FORS (ESO), PACS (Herschell)

Infrared magnitudes

Ground based IR observations vs. spatial observations.
-> why distinguish ?
- basics of radiation transfer in the IR : absorption and thermal emission.

- list various sources of energy in the IR in the universe : sun, planets, BDs @ 10 pc, stars @ 100 pc, galaxies, ...

Recall basic physics of detection and what happens in the infrared

Distinguish between 'IR detection' and 'IR imaging'
-> what does imaging bring apart from putting together a lot of individual detectors ?
Imaging calibrations :
- dark current
- dead pixels
- flat field : HF (detector) & LF (optics)
- flux response

People think to IR imaging between 1-2.5μm, where imaging looks very much like in the visible. If one wants to learn about "IR imaging", one has to investigate imaging $> 3\mu$m.

"Optical" IR imaging :
ISAAC / VLT : 1-2.5 & 3-5 μm (JHKLM) ; emissivity (freshly coated mirror) : 0.17.
ISAAC : Hawaii array 1-2.5 μm ; ALADDIN array 3-5 μm.

WIRCAM / CFHT : JHK

Thermal NIR imaging :
NAOS-CONICA / VLT : JHKLM
VISIR : 256x256 BIB detector

FIR imaging (spatial) :
A sampling of imaging detectors :
Spitzer : IRAC, MIPS.
IRAC = 256x256 pixels InSb / Si:As.
MIPS = 128x128 Si:As, 32x32 Ge:Ga, 2x20 Stressed Ge:Ga

Herschel : PACS, SPIRE
SPIRE : 139, 88, 43 detectors @ 250, 350, 500 μm
PACS : 60-85 μm / 85-130 μm and 130-210 μm imaging. Bolometer arrays: 32x16 and 64x32 pixels Point source detection limit: ~3mJy (5σ, 1h)

Review the currently available infrared detectors on ground-based facilities and on spacecrafts and learn to use their observation simulators.
!! use only instruments available to european people.
* future or soon to be available instruments

Gemini : NIRI / 1024x1024 ALADDIN InSb 1-5μm

Kind of large (basic physics) / small (web simulator) end of the spyglass

Use the image of the atmospheric transmission from 0 to 1 mm : illustrate the difference between ground-based imaging and spatial imaging.

The basics of radiation transfer : imaging through a translucent medium.
Thermal emission vs. black body emission (illustrate via the Mauna Kea atmospheric emission vs wvl).

The various magnitude systems : Vega & AB & STmag (HST)
? does STMAG include the NIR ?

Conversion between different magnitude systems

Examples : plan various applications from the optical style to the thermal IR style