SAFARI

the Imaging Spectrometer on the SPICA space observatory;
revealing the origins of the universe,
from planets to galaxies.

Peter Roelfsema
SAFARI PI
on behalf of the SAFARI consortium

SRON
Netherlands Insitute for Space Research

Netherlands Organisation for Scientific Research

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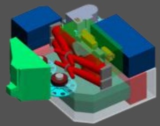
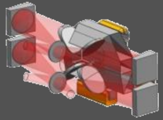
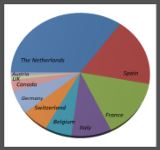
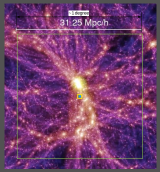
Overview

- SPICA/SAFARI – (far) infrared space astronomy
    - Science drivers
- The SAFARI project
    - The baseline instrument
    - Transition Edge Detectors
- Project context
    - Consortium composition
    - Planning and progress
- SAFARI science outlook







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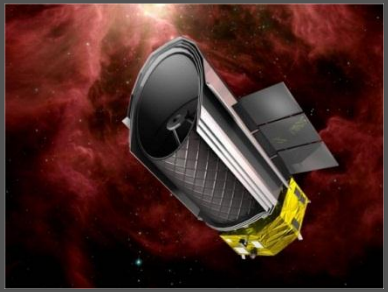
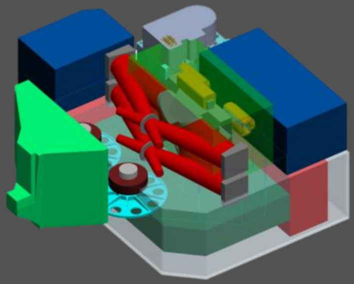
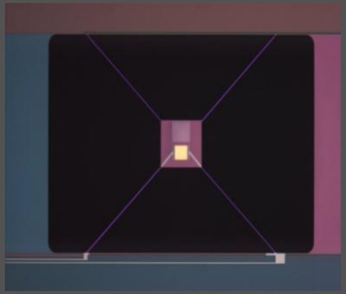
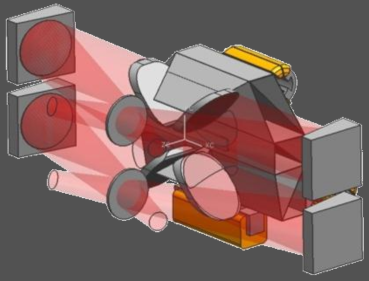
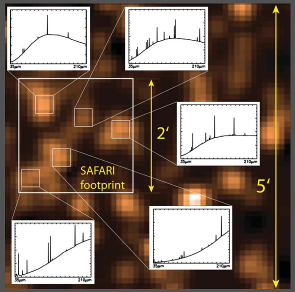
SPICA/SAFARI
the science drivers



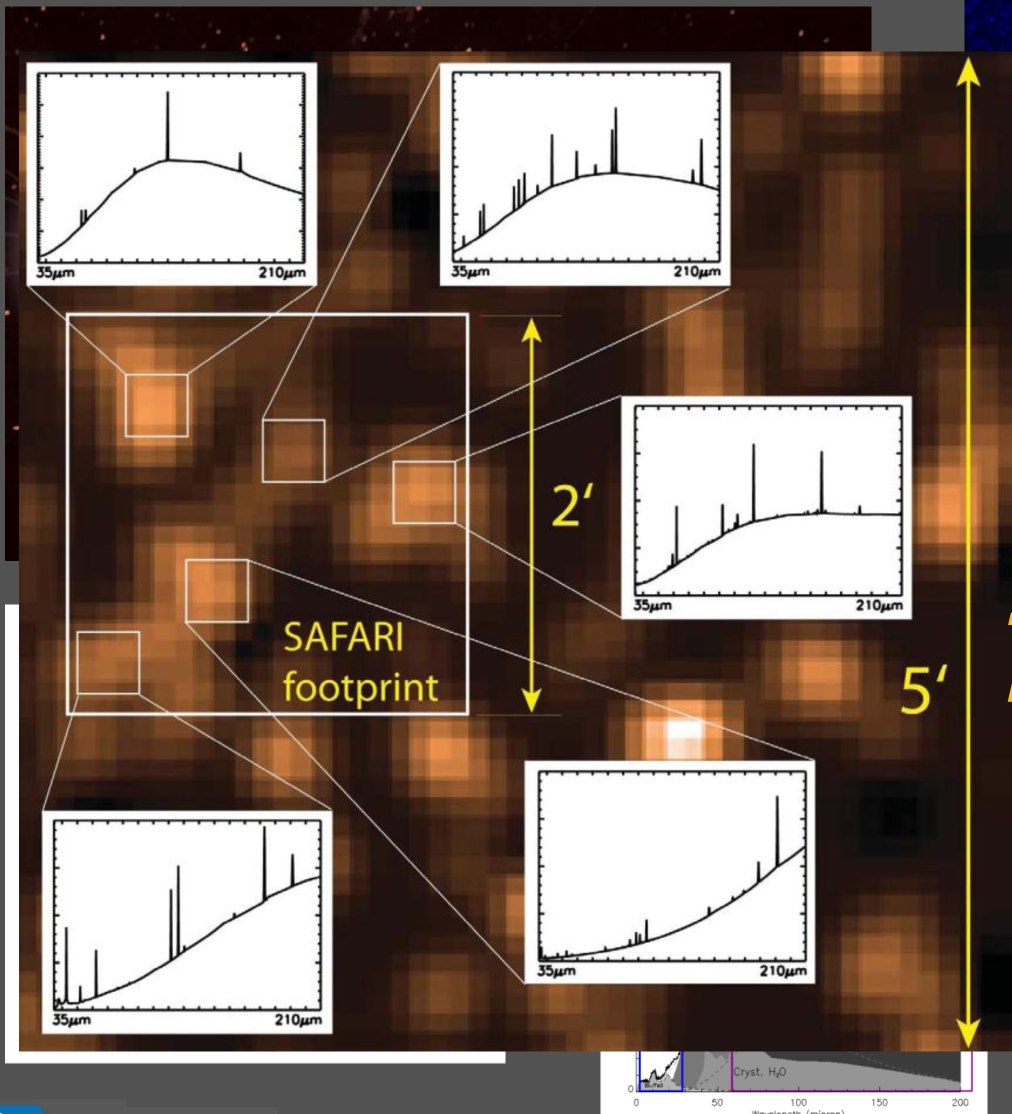


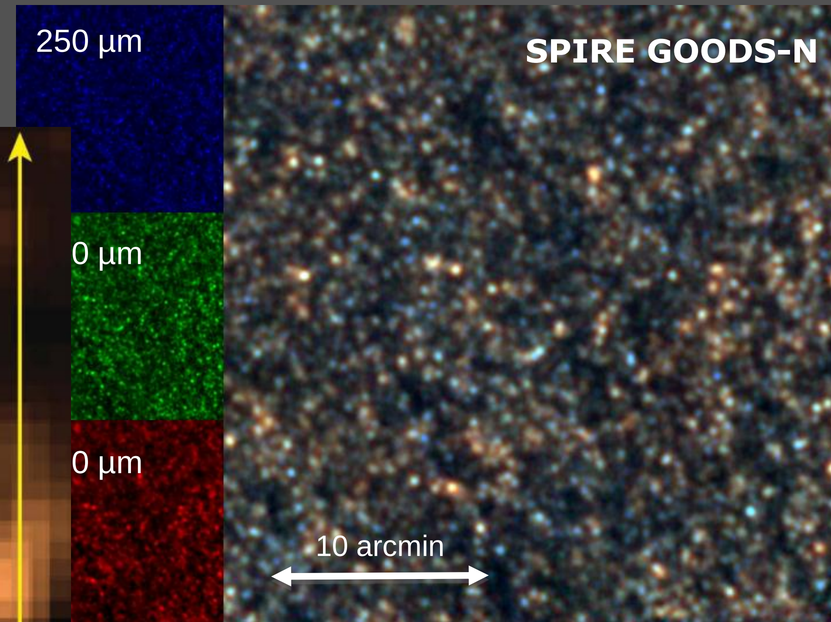






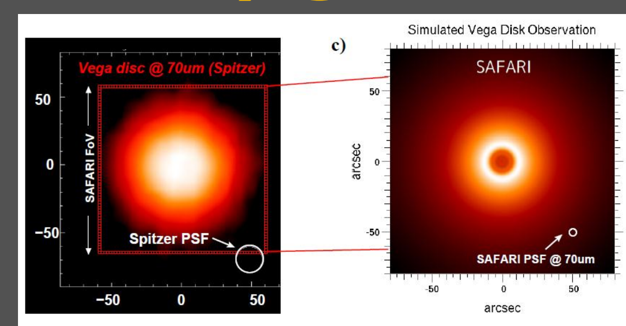
SPICA's science issues



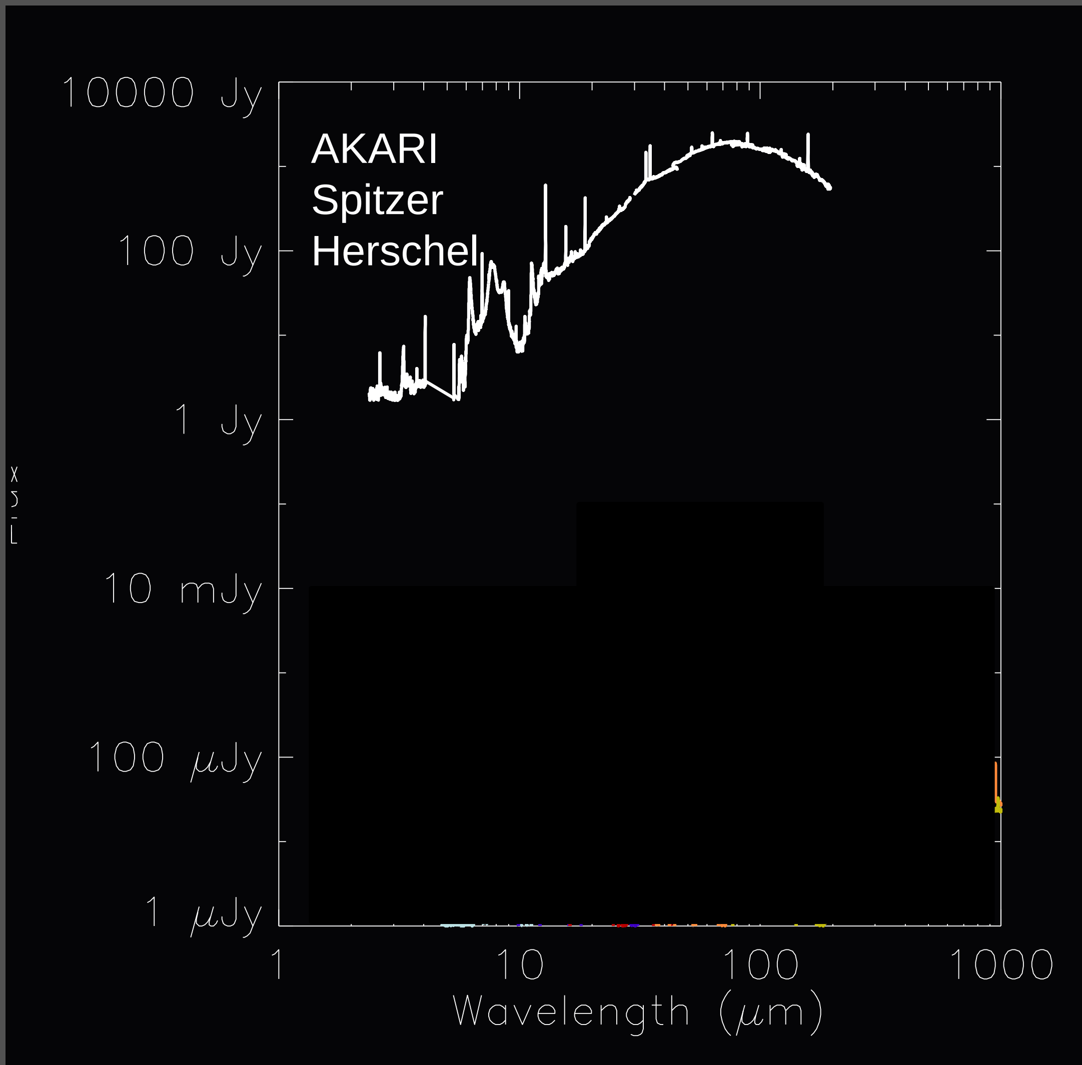


…all this requires imaging spectroscopy

→ SAFARI



Characterizing the hidden nature of galaxies



Revealing true nature of obscured galaxies

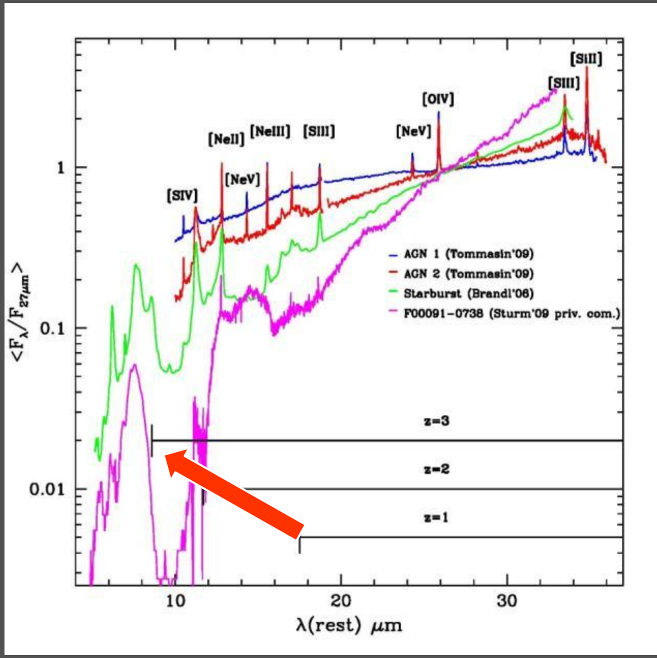
Looking at the more distant objects:

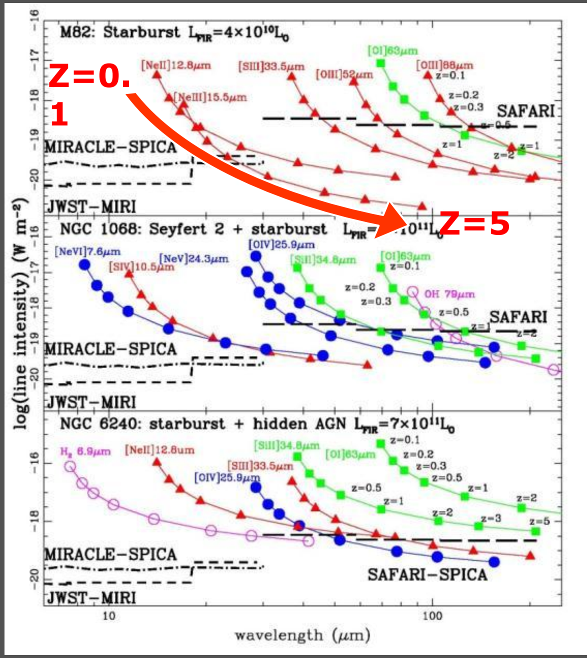
SAFARI fills a very fundamental gap…

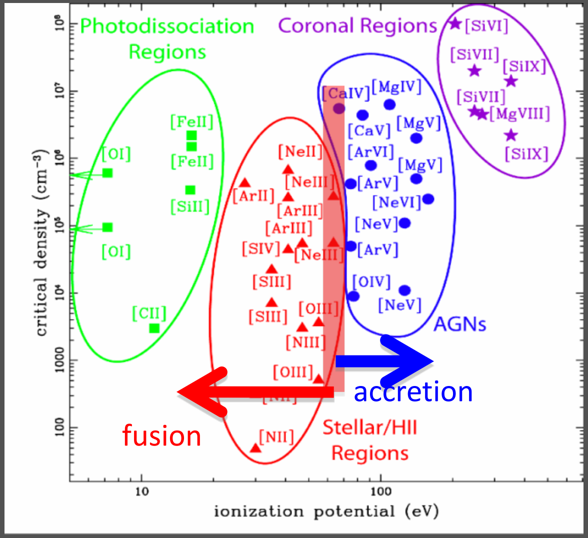
…becomes possible with sensitivity and Field of View

FAR-IR diagnostics out to large redshift

- Key lines shift from MID-IR to FAR-IR from z~1
  - IR has key diagnostic lines out to z > 3 even in obscured system
  - Galaxies observable out to large z
  - Cover a large IR range → multiple lines in single observation
  - Large increase in range of stages and conditions of evolution
  - Trace the coevolution of star formation and mass accretion

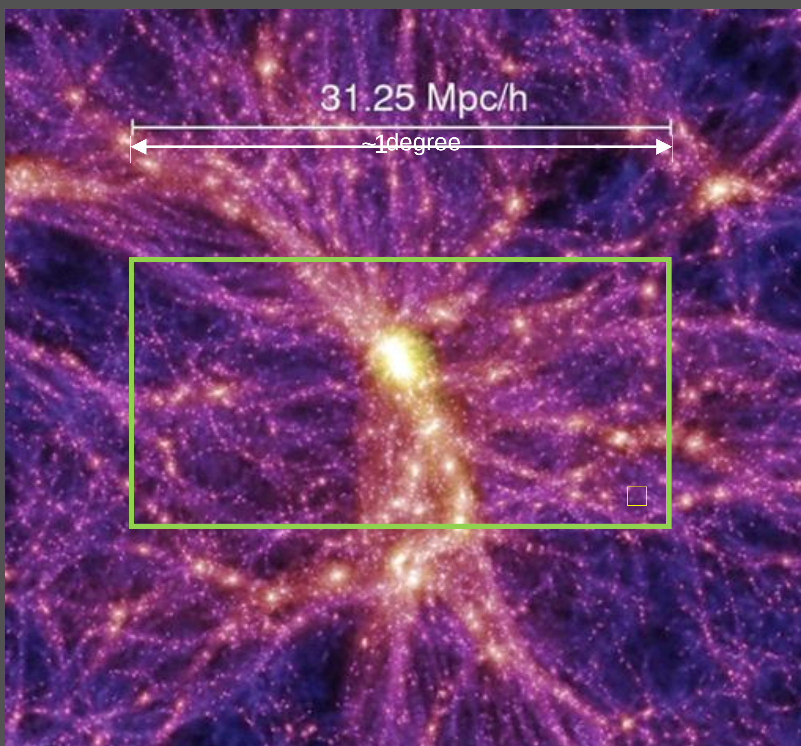






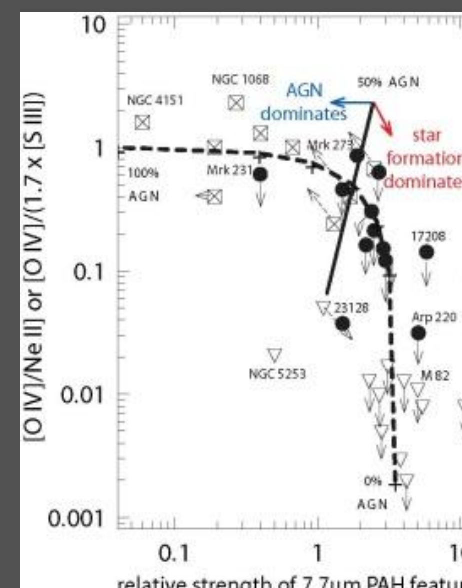
High throughput spectroscopic surveys

- For blind spectroscopic surveys with SAFARI detection of large numbers of galaxies is predicted
  - E.g 0.5 square degrees, ~500 hrs observing time → $\sigma \sim$ few$\times 10^{-19}$ Wm^{-2}
  - Various galaxy evolution models with 5σ detection limit
- Models typically predict *~2000* objects detected in *at least 4 lines*



Line		# sources
PAH	**11.25µm**	715
[NeII]	**12.81µm**	228
[NeV]	**14.32µm**	60.7
[NeIII]	**15.55µm**	113
[SIII]	**18.71µm**	55.8
[NeV]	**24.32µm**	37.8
[OIV]	**25.89µm**	232
[SIII]	**33.48µm**	1753
[SIII]	**34.81µm**	2713
[OIII]	**51.81µm**	2983
[NIII]	**57.32µm**	567
[OI]	**63.18µm**	5611
[OIII]	**88.35µm**	4274

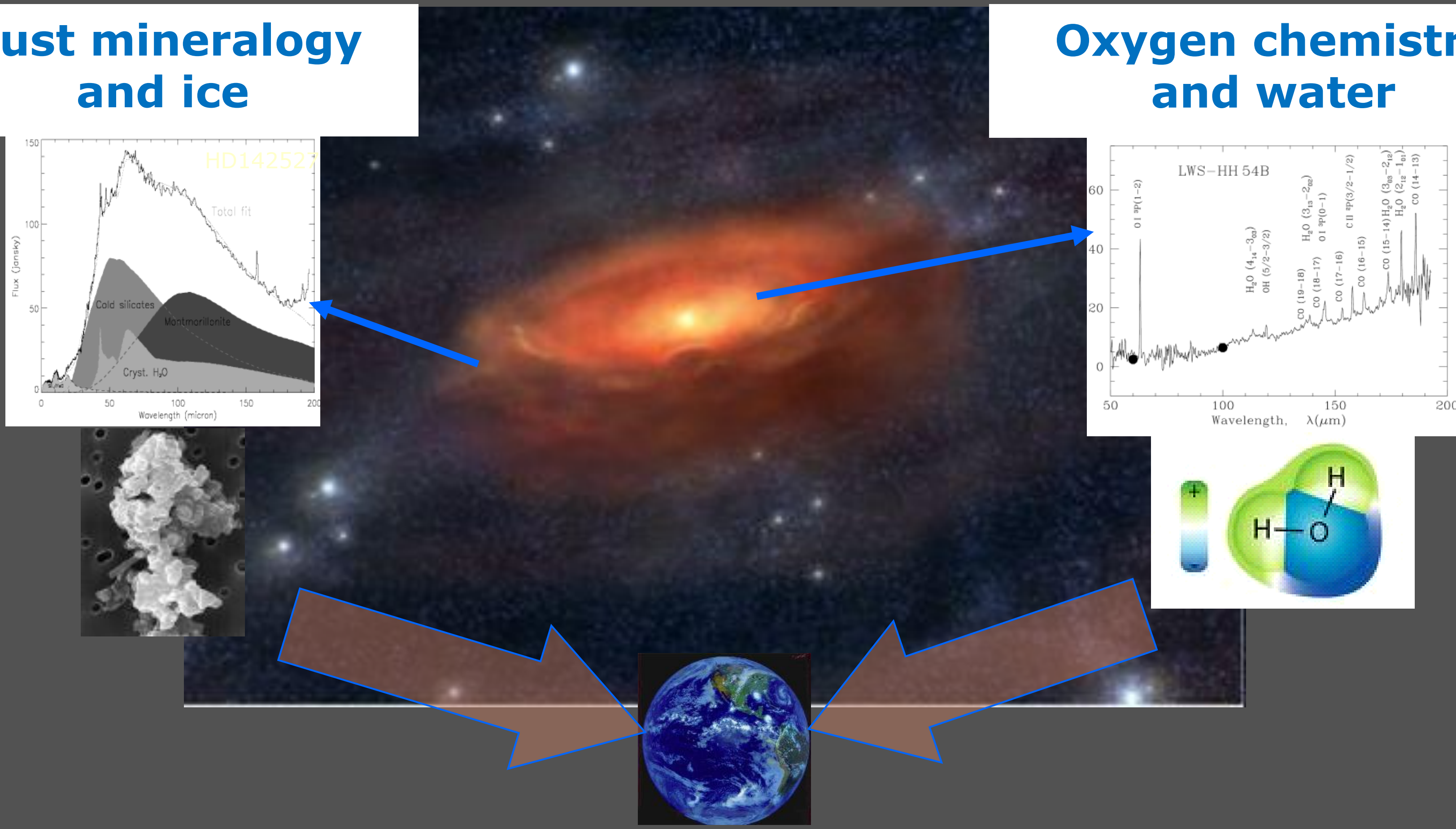
AGN PDR HII region



Chemistry of Planet Formation Regions

Dust mineralogy and ice

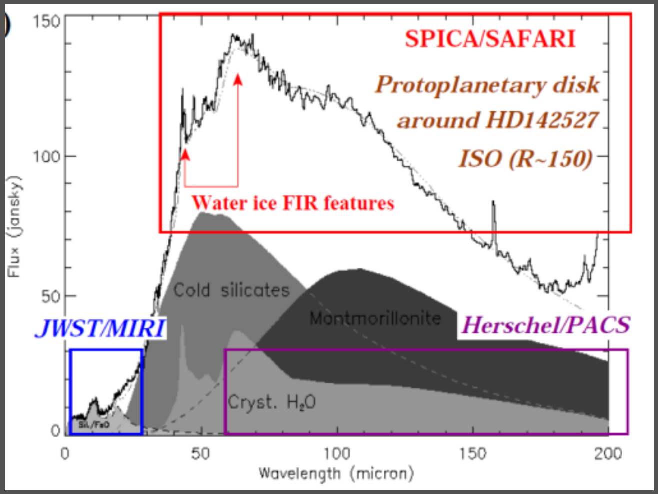
Oxygen chemistry and water



Rocky planets and oceans

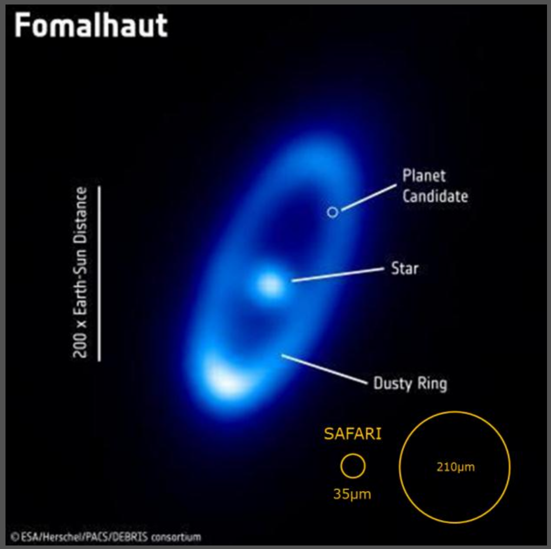
For the next step high sensitivity (weak lines) and high dynamic range (central star) is needed

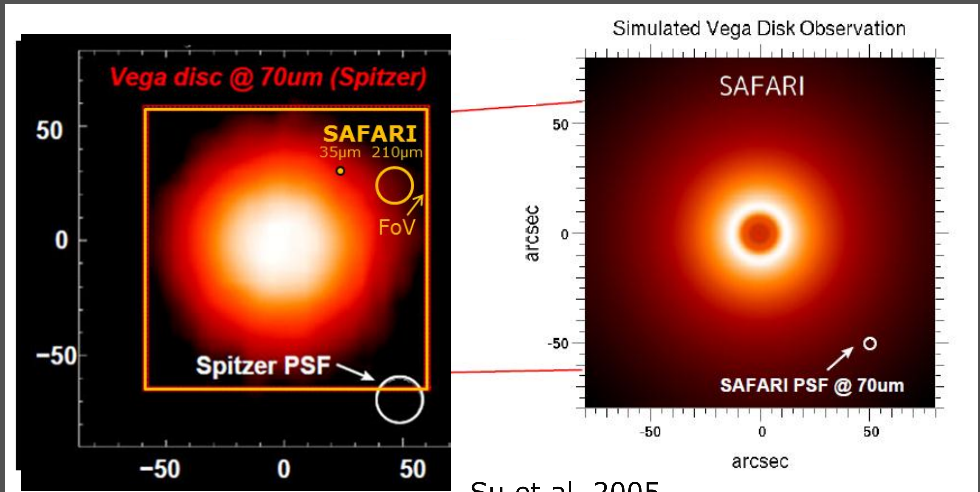
Planetary disks – resolving the "snow line"



- Amorphous and crystalline H_2O ice (44/62 μm) → thermal history
- Water ices important in grain coagulation → planet formation
- Water first hydrogenated molecule to freeze out (T<150 K); marks "snowline" → gaseous/rocky planet boundary

SAFARI will allow *detailed mineralogy* in many systems…





Su et al. 2005

…and will provide resolution to *image snowlines* in local systems

@44mm, SAFARI beam ~30AU at distance of Vega cf. snowline in A-type stars at 22-44AU.

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The limits in Infrared sensitivity

- We want to be limited *only by the natural background* in the universe
- For signals in the FarInfrared this means a telescope colder than ~6K

  We need SPICA to provide the low background…

  …and instruments –e.g. SAFARI– to provide the extreme sensitivity