Silicates through the eye of ISO

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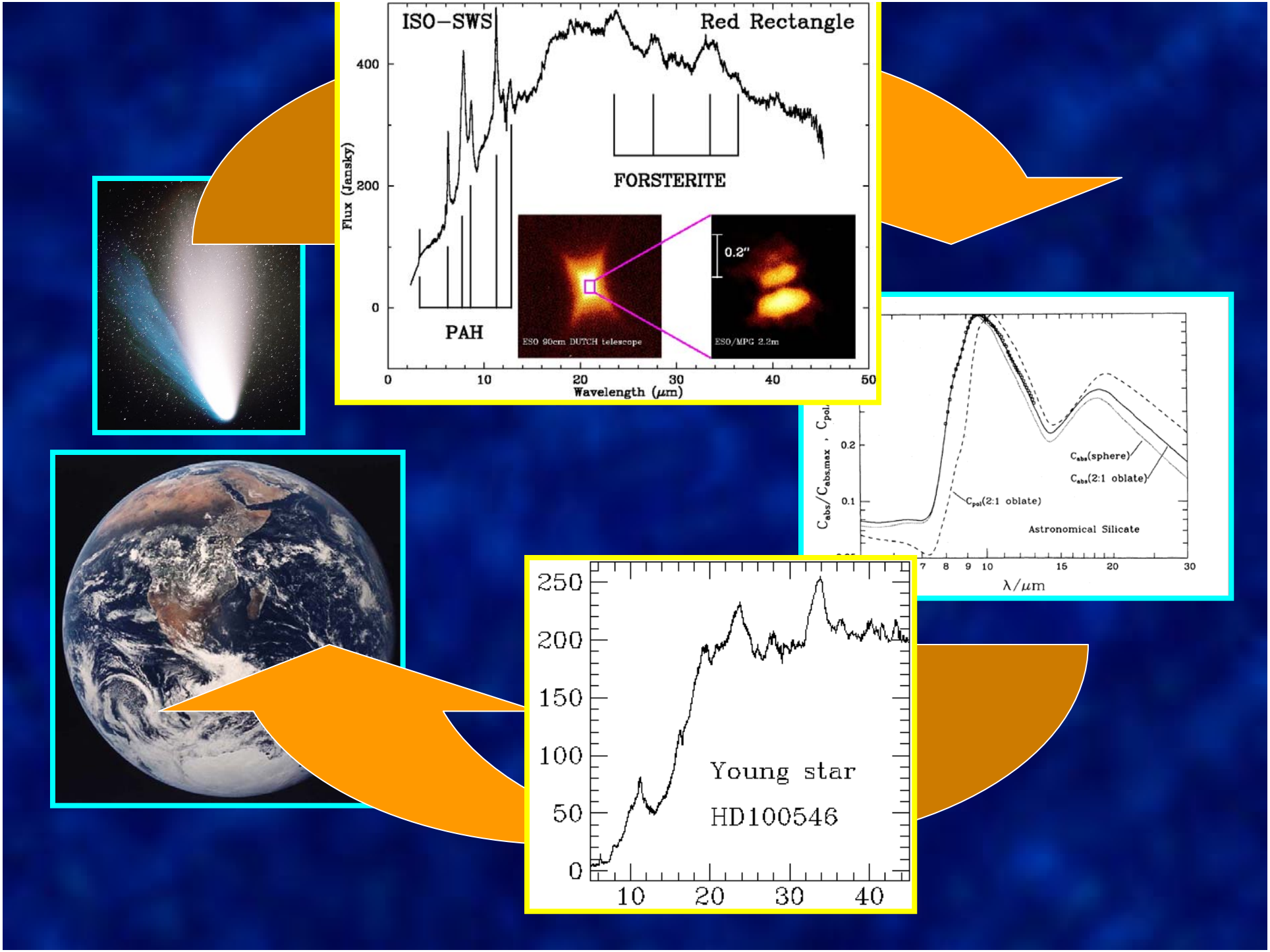
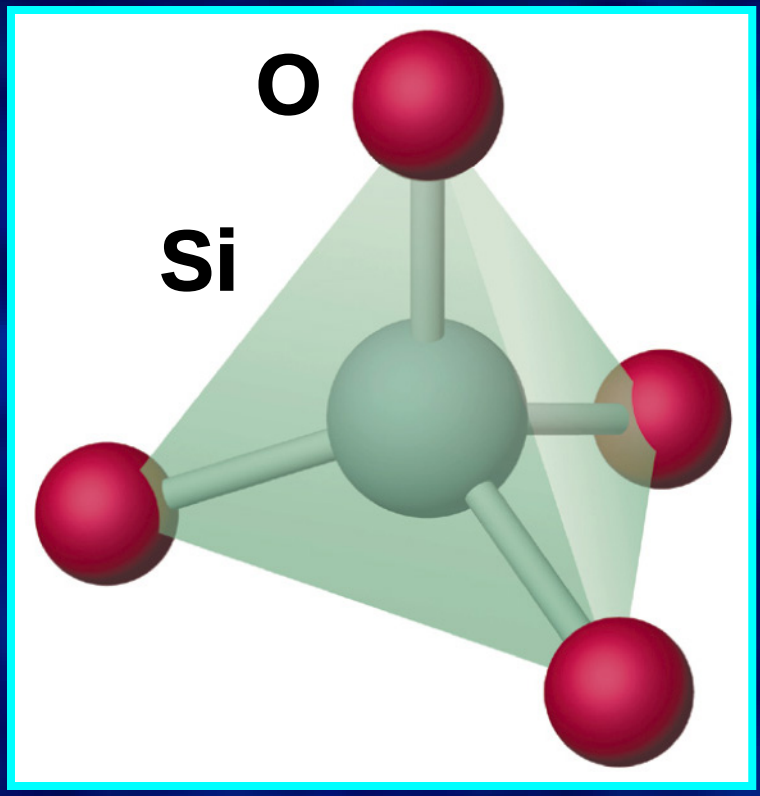

ISO–SWS
Red Rectangle
FORSTERITE
PAH
Flux (Jansky)
Wavelength (μm)
ESO 90cm DUTCH telescope
ESO/MPG 2.2m
0.2"
C_{abs}(sphere)
C_{abs}(2:1 oblate)
C_{pol}(2:1 oblate)
Astronomical Silicate
λ/μm
Young star
HD100546

Silicates: the building blocks

- silicate anion

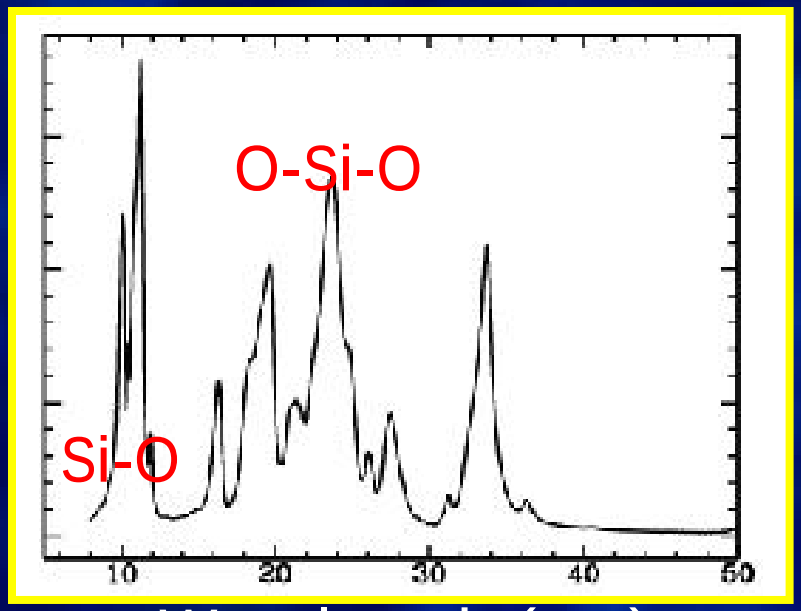
  SiO_4^{4-}



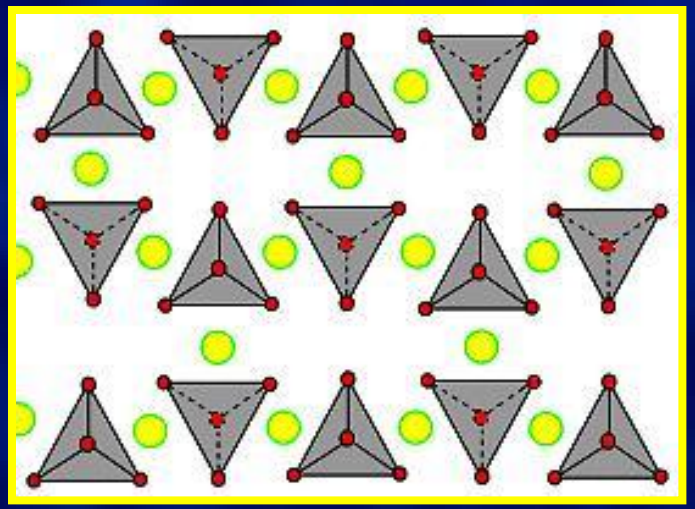
- Metal cation

  Mg^{2+}, Fe^{2+}, Ca^{2+}...

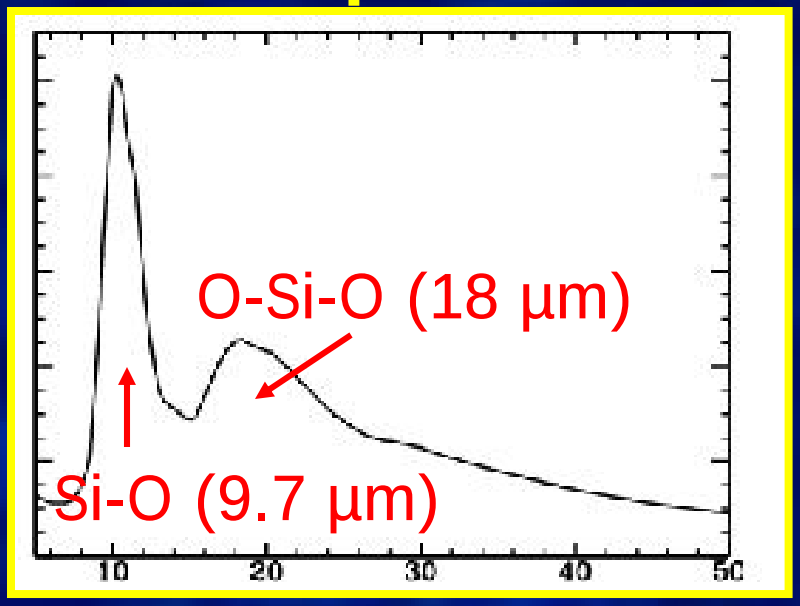
Crystalline



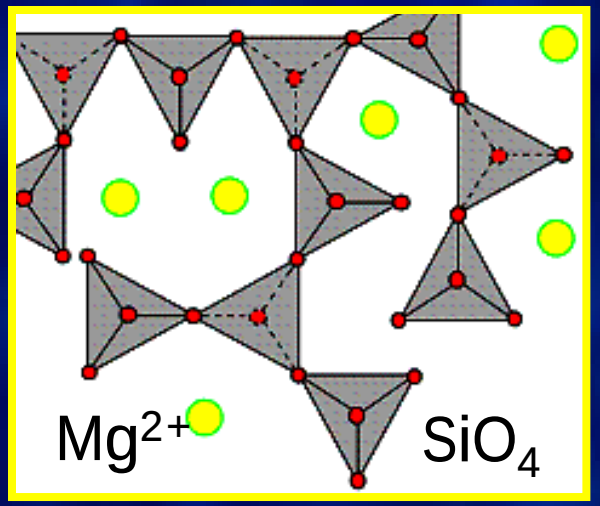
→Wavelength (μm)



Amorphous



→Wavelength (μm)



Crystalline or amorphous?

- Energetic processing: thermal annealing
- Radiation damage
- The degree of crystallinity *x* is defined as:

$$x = m_{\text{crystalline silicates}} / m_{\text{total silicates}}$$

The life cycle of silicates

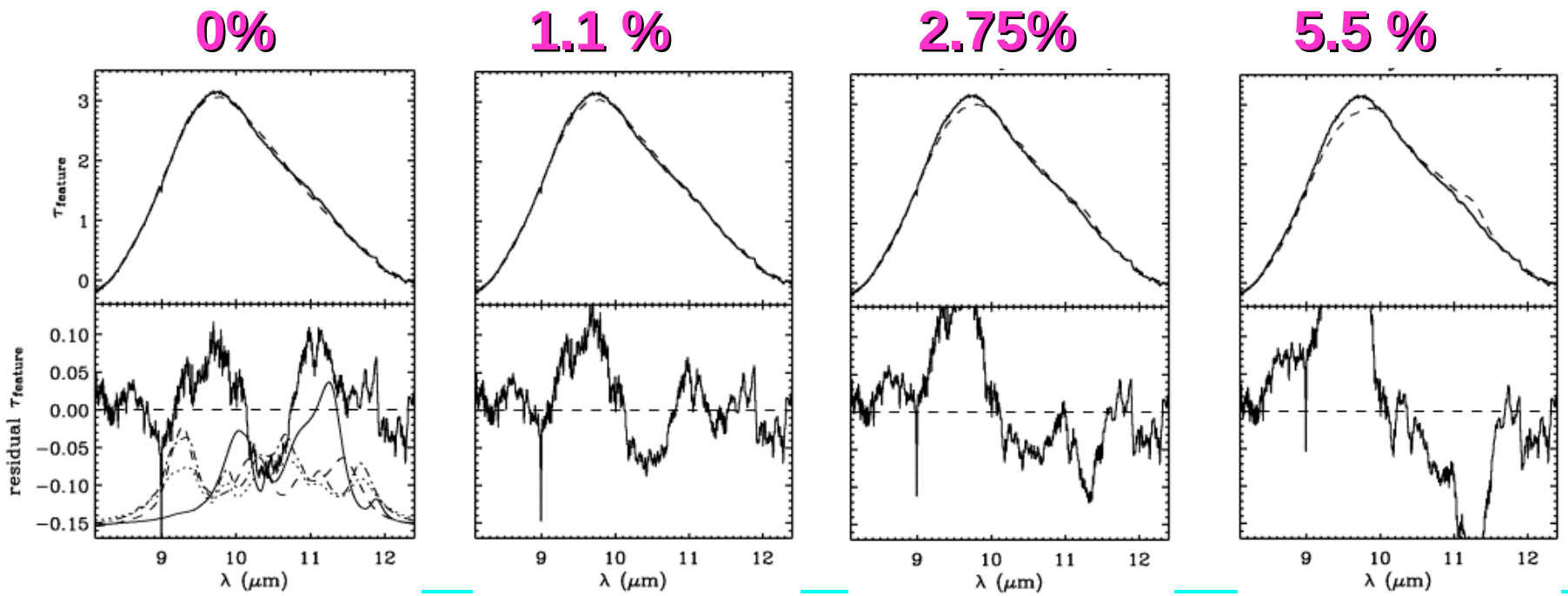
crystallinity *x*

Evolved (AGB, PN, RSG)	11-18 %
Evolved (SN)	*New facilities*
Diffuse ISM	<2 %
Molecular clouds	*New facilities*
Herbig Ae/Be, T Tau stars	5-8 %
Debris disks	*New facilities*
Solar system	~100%

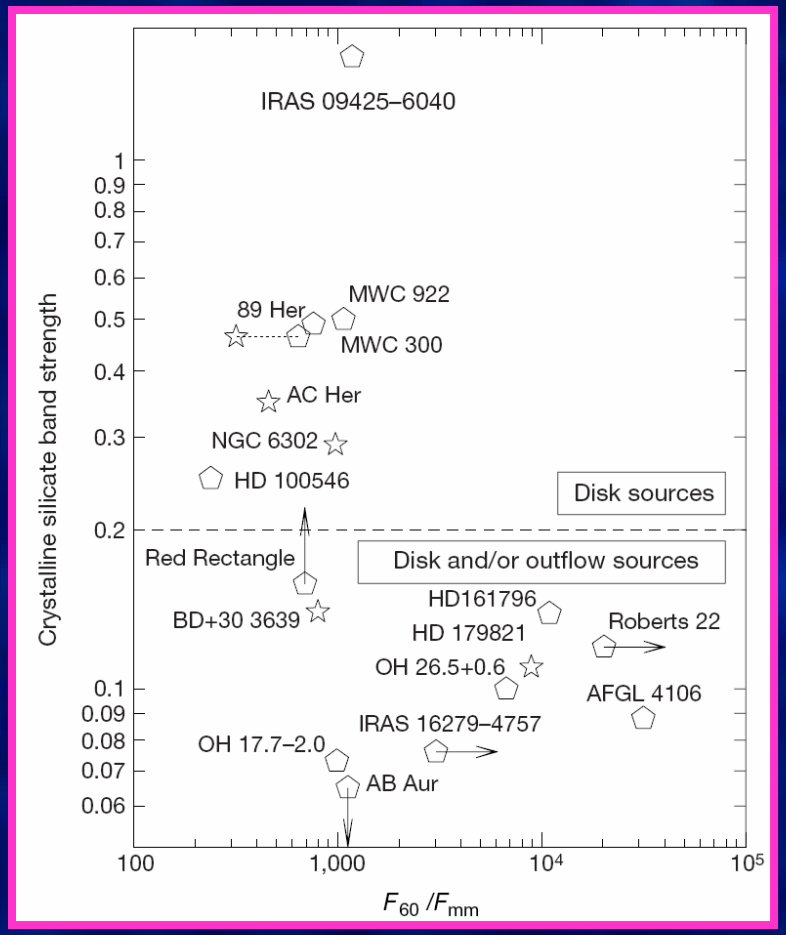
Interstellar silicates

The diffuse ISM is ~1.1% crystalline, but definitely <2.2%

Kemper et al. 2004, 2005



Grain growth & crystallization



crystallinity x

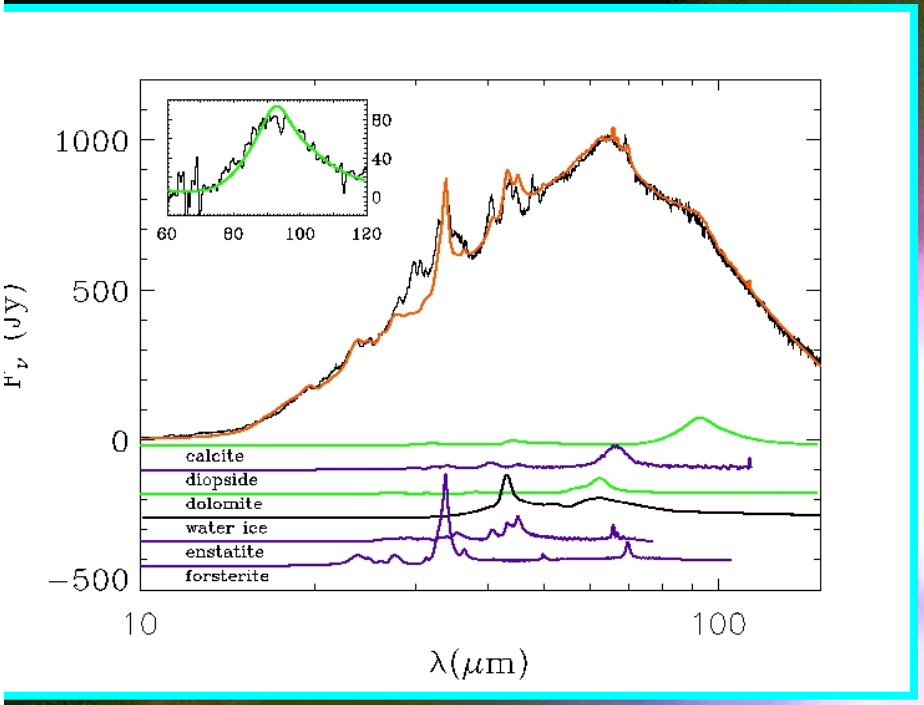
grain size

Correlation:

- Crystallinity
- Grain size
- Presence of disk

Molster et al. 1999

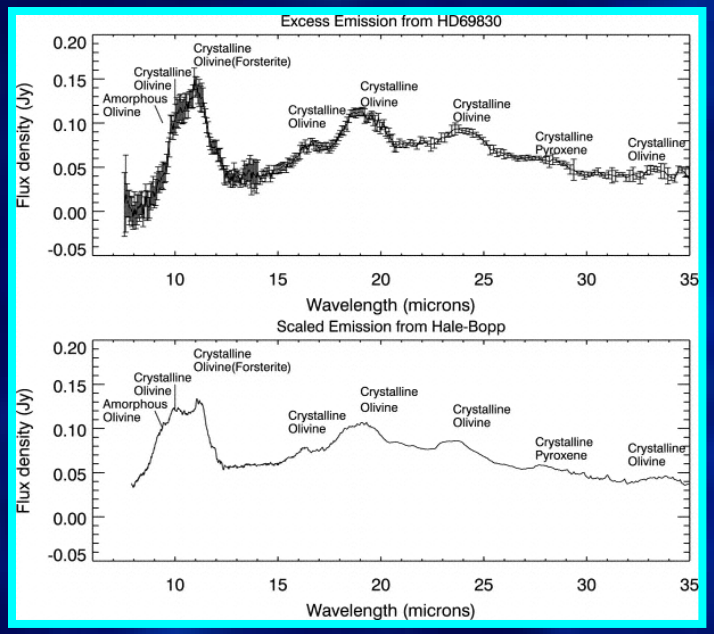
A gateway to astromineralogy



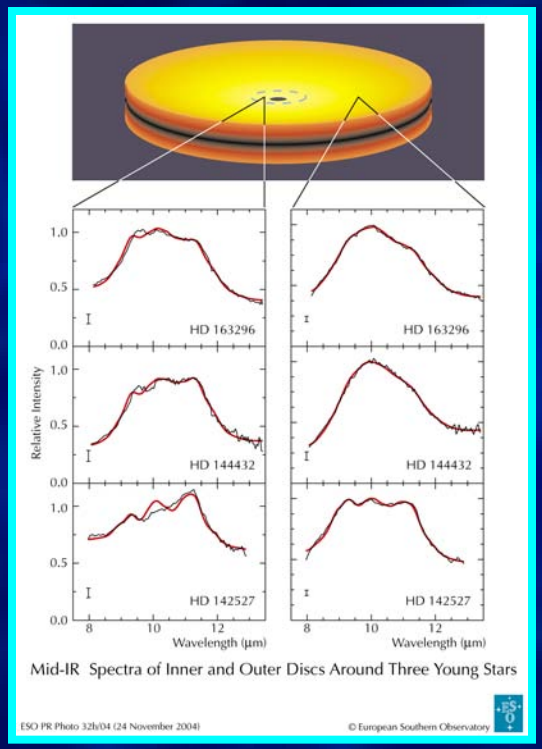
Kemper et al. 2002

Setting the trends for new facilities

Disk evolution

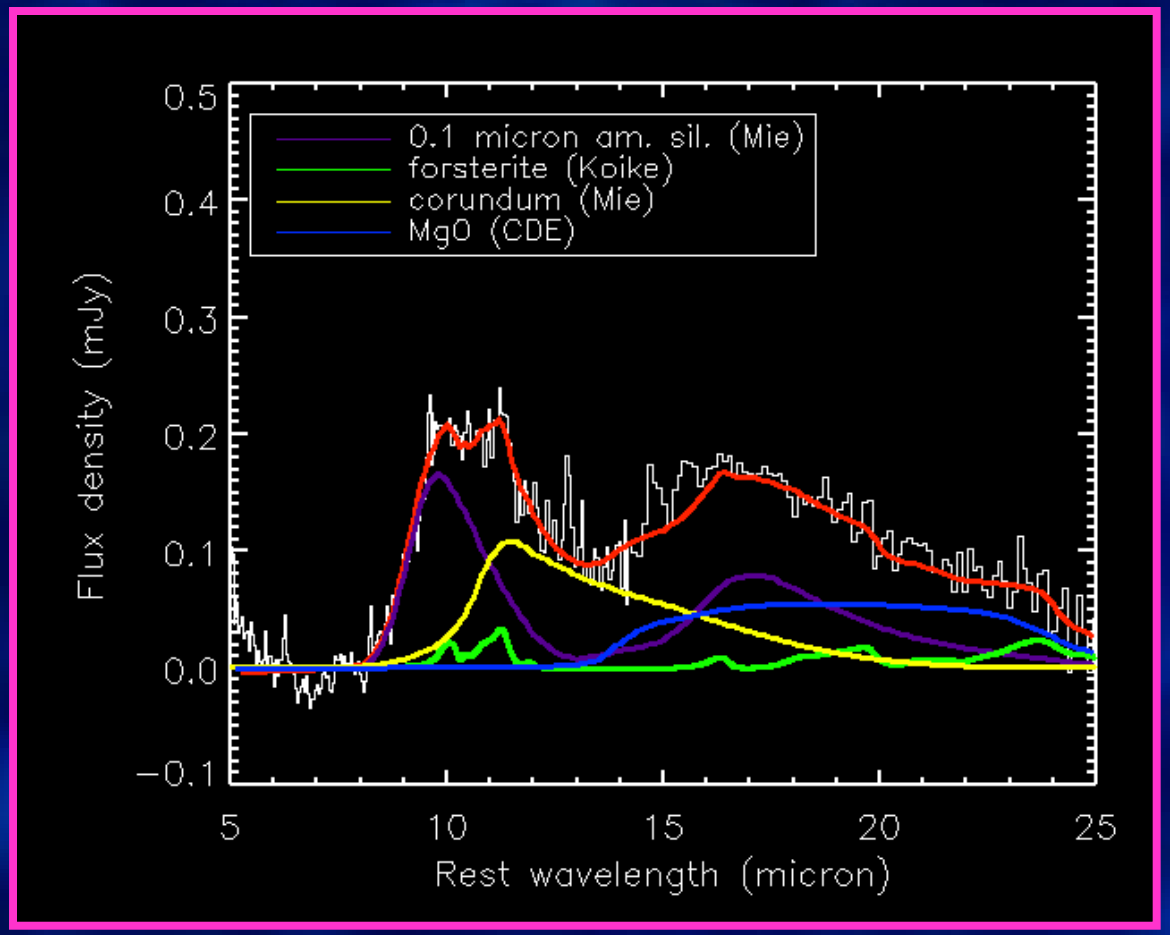


Beichman et al. 2005



van Boekel et al. 2004

Active galaxies



Markwick-Kemper et al.

Crystalline silicates

- Important ISO discovery and legacy
  - From nothing to main thing
- Traces thermal processing, cosmic ray irradiation and shocks
- Opened up field of astromineralogy
- Future promise:
  - Disk evolution, grain growth, planet formation
  - Processing in active galaxies