Crystalline Silicate Emission in the Protostellar Binary Serpens-SVS20

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Introduction

- SVS20 Flat/Class I Binary Protostellar System
- Located in Serpens (d~250 pc)
- Binary Separation: 1.5'' (375 AU)
- Part of a young cluster (10^5 years)
- Polarization indicates an evacuated cavity surrounding the binary
- Previous mid-infrared spectroscopy with ISO
  - Spatially unresolved
  - Showed both silicate emission and absorption

Observations

- Obtained ground-based mid-infrared (8 – 13 μm) spatially resolved photometry and spectroscopy

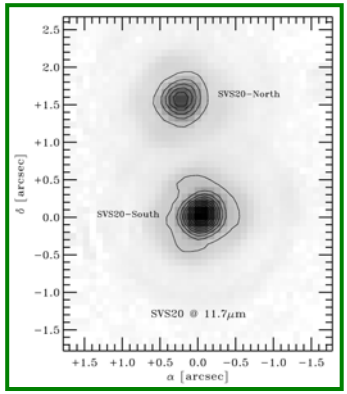
- Spectroscopy (8 – 13 μm)
  - T-ReCS on Gemini-South
  - 2003 October 05
  - R~111 at λo=10.5 μm (Δλ = 0.022045 μm/pix)
  - S/N ~ 50 – 70

- Narrow-Band Photometry
  - T-ReCS on Gemini-South
    - 11.7 μm (Δλ = 1.1 μm)
    - Pixel Scale = 0.089" pixel^{-1}
  - TIMMI-2 on La Silla 3.6m
    - 10.4 μm (Δλ = 1.0 μm)
    - 11.9 μm (Δλ = 1.2 μm)
    - 12.9 μm (Δλ = 1.2 μm)
    - Pixel Scale = 0.2" pixel^{-1}

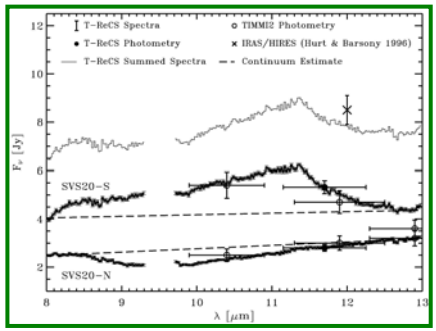
TABLE 1
SUMMARY OF MID-INFRARED FLUX DENSITIES

λ_c (μm)	SVS20-S F_ν (Jy)	SVS20-N F_ν (Jy)	Comments	Reference
8.0	4.0 ± 0.1	2.6 ± 0.1	T-ReCS Spectroscopy	1
8.0	6.16 ± 0.14		ISOCAM CVF Binary Unresolved	2
10.4	5.4 ± 0.5	2.5 ± 0.2	TIMMI2 Photometry	1
10.78	4.36 ± 0.26	1.53 ± 0.09	MIRLIN Photometry	3
11.7	5.32 ± 0.27	2.80 ± 0.14	T-ReCS Photometry	1
11.9	4.7 ± 0.5	3.0 ± 0.3	TIMMI2 Photometry	1
12.0	8.5 ± 0.6		IRAS/HIRES Binary Unresolved	4
12.9	3.6 ± 0.4	3.2 ± 0.3	TIMMI2 Photometry	1

REFERENCES. — 1. This work, 2. Alexander et al. (2003), 3. Haisch et al. (2002), 4. Hurt & Barsony (1996)



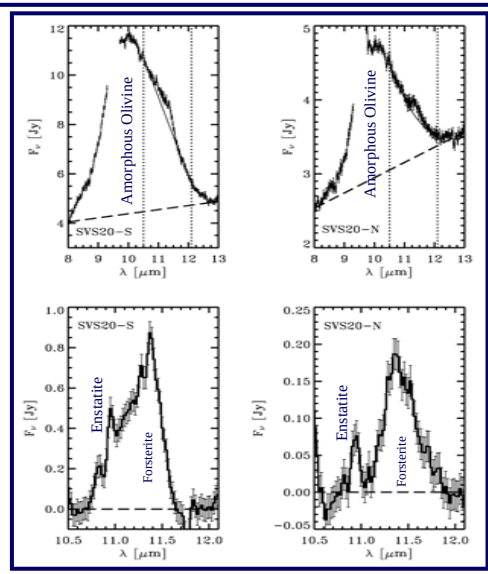
T-ReCS 11.7 μm image: Binary is clearly resolved. No evidence for extended emission. Emission from each contained within 50-100 AU of central source.



T-ReCS Spectroscopy: Mid-infrared spectra for SVS20-S and SVS20-N. The individual data points represent photometry presented in this work (T-ReCS & TIMMI2 photometry) and from the literature (IRAS). The summed spectrum is presented for ease of comparison to the unresolved IRAS photometry. The data near telluric ozone (9.3 < λ< 9.7 μm) have been removed because of uncertain ozone subtraction. The continua estimates are shown as the dashed lines. The photometry is summarized in Table 1

Estimate of Envelope Extinction

- Envelope extinction estimated from 3.1 ice feature
  - A_V~ 14 mag (Eiroa 1987)
- Created model of amorphous olivine extinction
  - 0.15 μm grains
  - Peak Optical depth at 9.7 μm
  - τ(9.7 μm) ~ 0.82
- Multiplied observed spectra by model exp(τ_λ)
- Produces "protostar-only" mid-infrared spectra



T-ReCS spectra after removal of envelope extinction. Main features identified. Gaussian (2 pixel) smoothed.

Results

- Protostellar spectrum dominated by amorphous silicate emission
  - Peak at λ ~ 10 μm (not 9.7 μm)
  - Indicative of amorphous olivine grain growth
- Local emission feature near 11.3 μm
- Continuum subtraction reveals crystalline grain growth
  - Broad forsterite peak at 11.3 μm
  - Narrow enstatite peaks at 11.0 and 11.4 μm

•Crystalline grain growth begins at very early evolutionary stages!!