# Wavelength Dependence of Far-IR and Submillimeter Polarization

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**Data**: Clouds forming massive stars
KAO 60 μm, 100 μm
CSO 350 μm
[JCMT 850 μm]
[NRAO 1300 μm]

**Observations**:

I) Cloud cores (flux maxima):
Often, $dP/d\lambda > 0$. (Optically thick ⇒ optically thin?)
In one unusual case, $dP/d\lambda << 0$. (abs. in Sgr B2)

II) Cloud envelopes (everywhere else):
A) $d\theta/d\lambda <> 0$ ⇒ Magnetic field structure + multiple cloud (temperature) components

B) $d\theta/d\lambda \approx 0$: Observe $dP/d\lambda < 0$ ($\lambda$=60-350 μm).
⇒ Multiple dust components
1) Emissivity index ($\beta$)/polarization correlation
2) Temperature/polarization correlation

References:

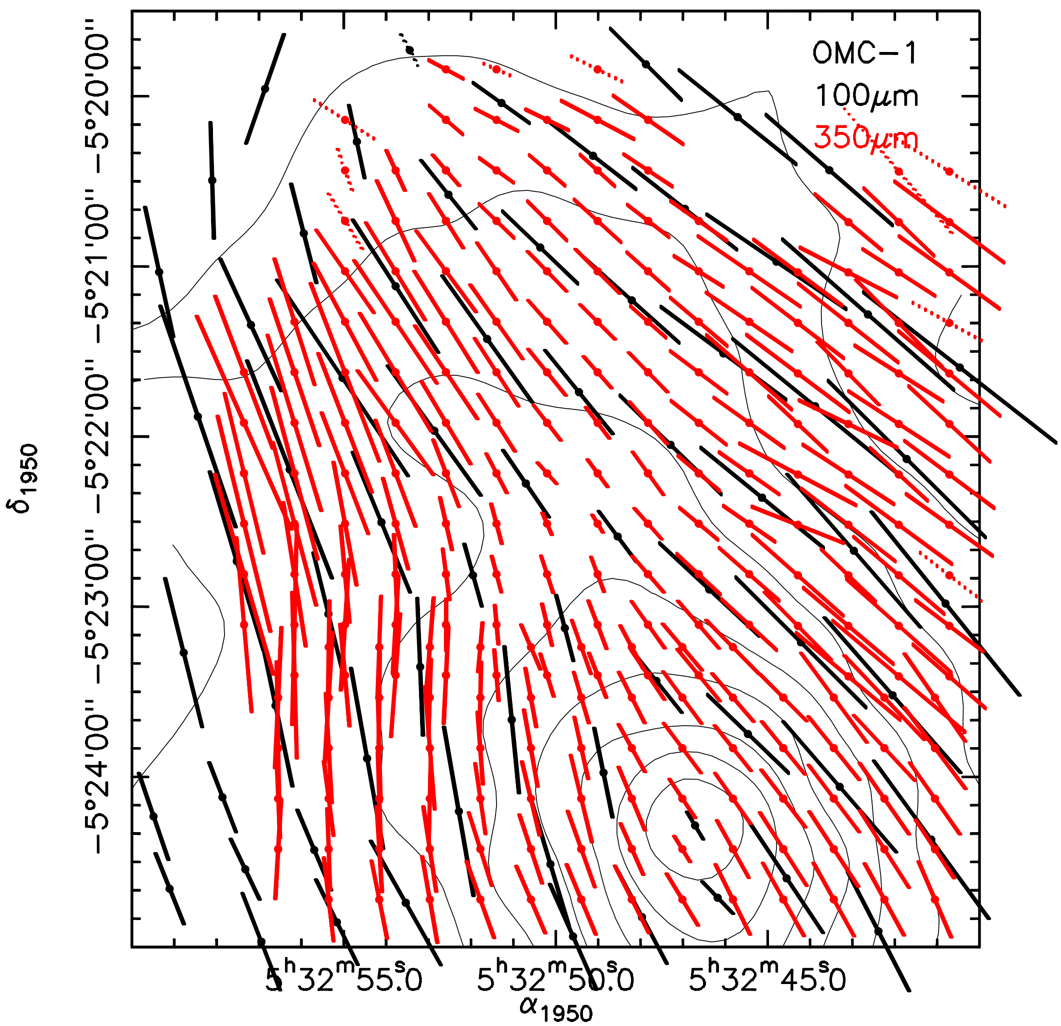
Hildebrand et al. (1999) – ApJ 516: 834 – $dP/d\lambda < 0$ in envelopes
Schleuning (1998) – ApJ 493: 811 – $dP/d\lambda > 0$ in Orion core
Dowell (1997) – ApJ 487: 237 – $dP/d\lambda << 0$ in Sgr B2 core

# Polarization Histograms: KAO and CSO

(Figure to be pasted in.)

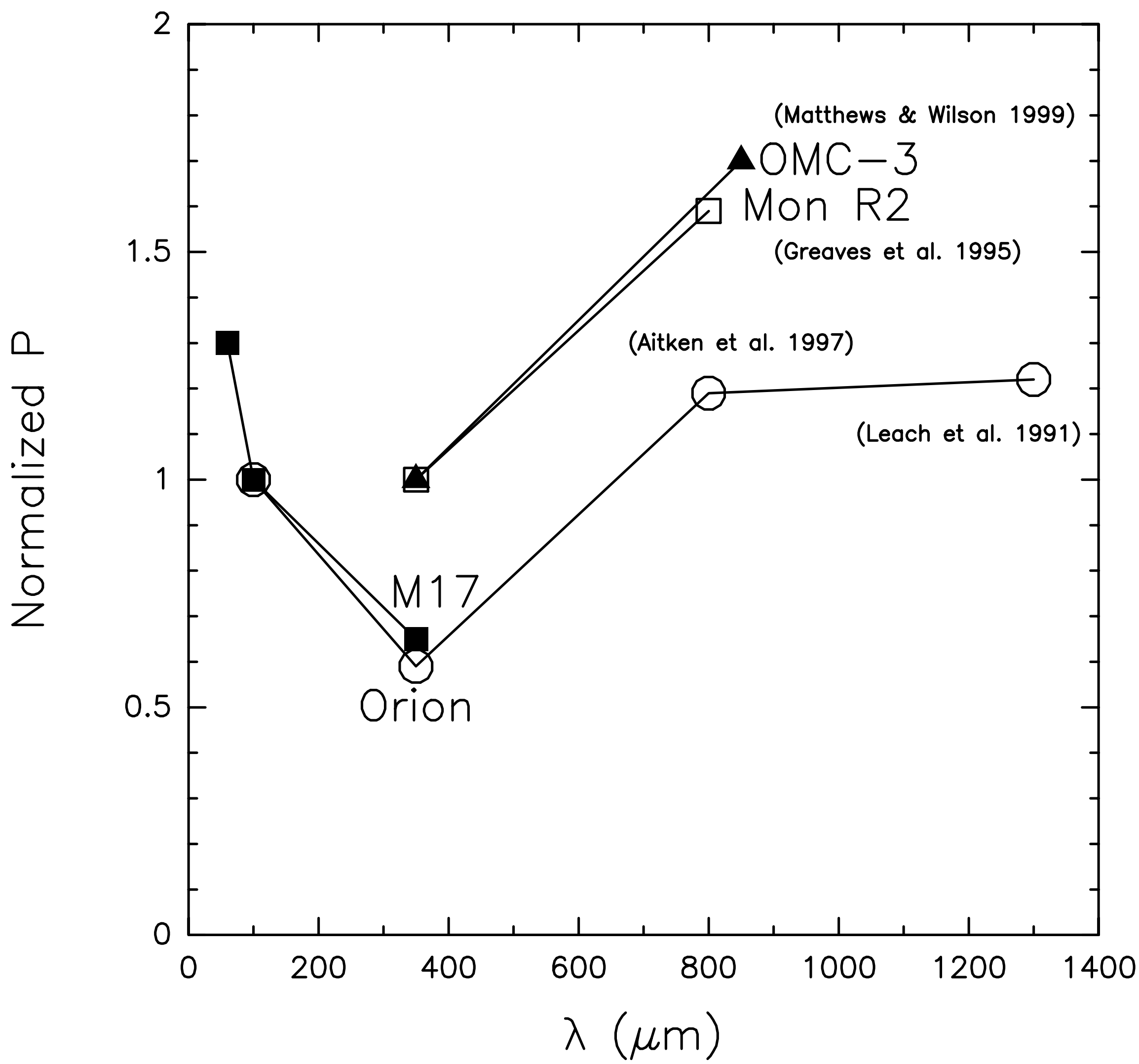
Note: Complete data sets with only partial overlap of sources. See Hildebrand et al. (1999).

# Orion Envelope Polarimetry




P(350 μm)/P(100 μm) = 0.59.

# FIR/Submm Polarization Spectrum



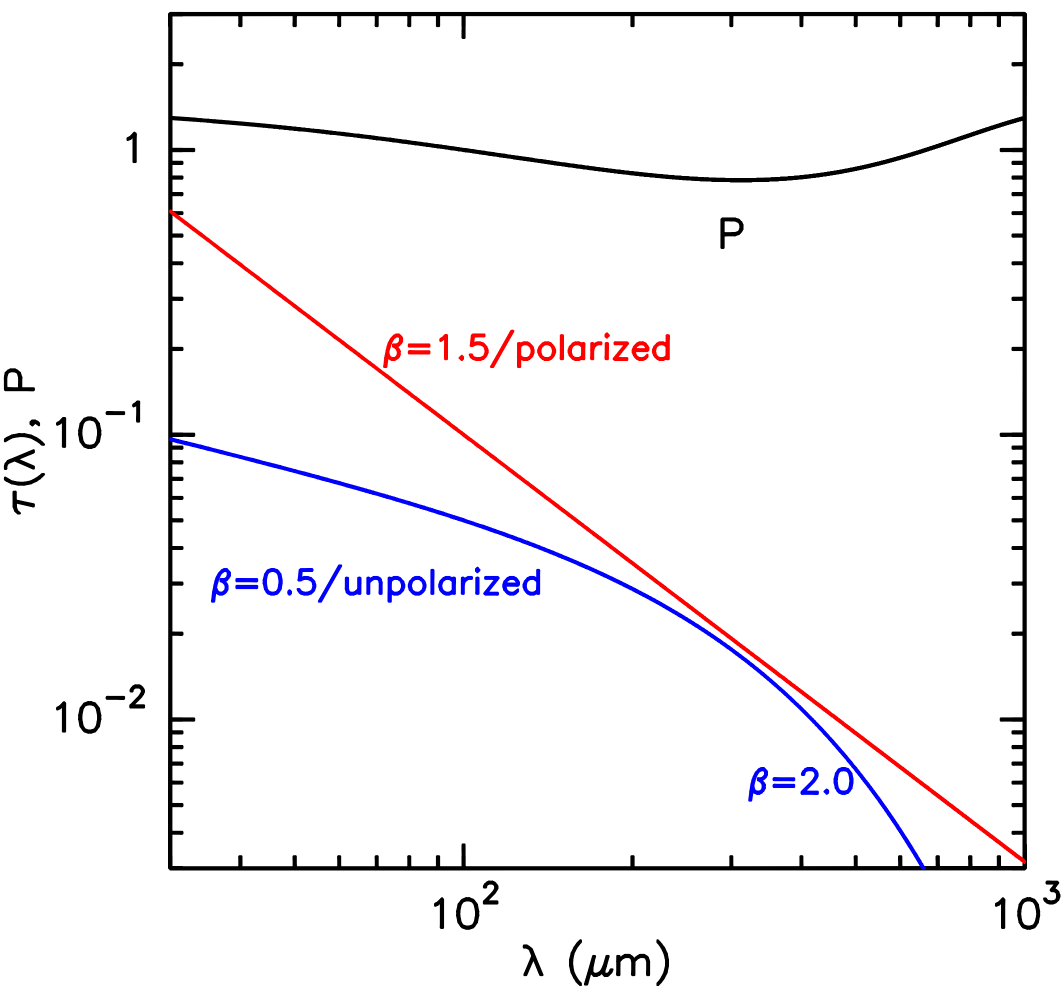
# <u>FIR Polarization Spectrum –</u>
# <u>Not the Signature of a</u>
# <u>Single Grain Species</u>

(Figure to be pasted in.)

Oblate grains, a/b = 0.5.  See Hildebrand et al. (1999).

# Explanations for Dip in Polarization Spectrum

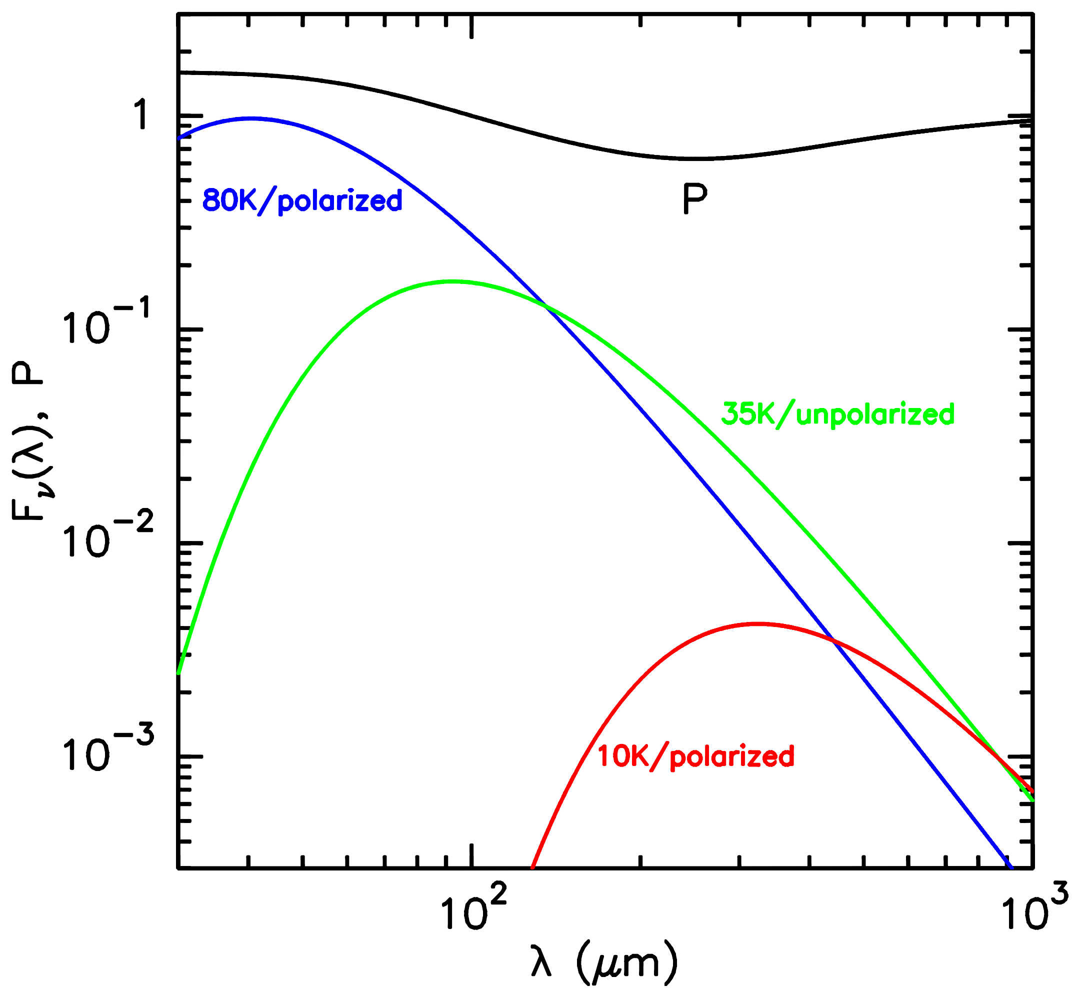
1) 2+ grain components, one polarized and one not, with different β's:




Silicate/graphite (1:1) with Draine(1985) emissivity can reproduce **neither** the steepness of the 60-350 μm polarization spectrum **nor** the rise toward 1 mm.

# Explanations for Dip in Polarization Spectrum

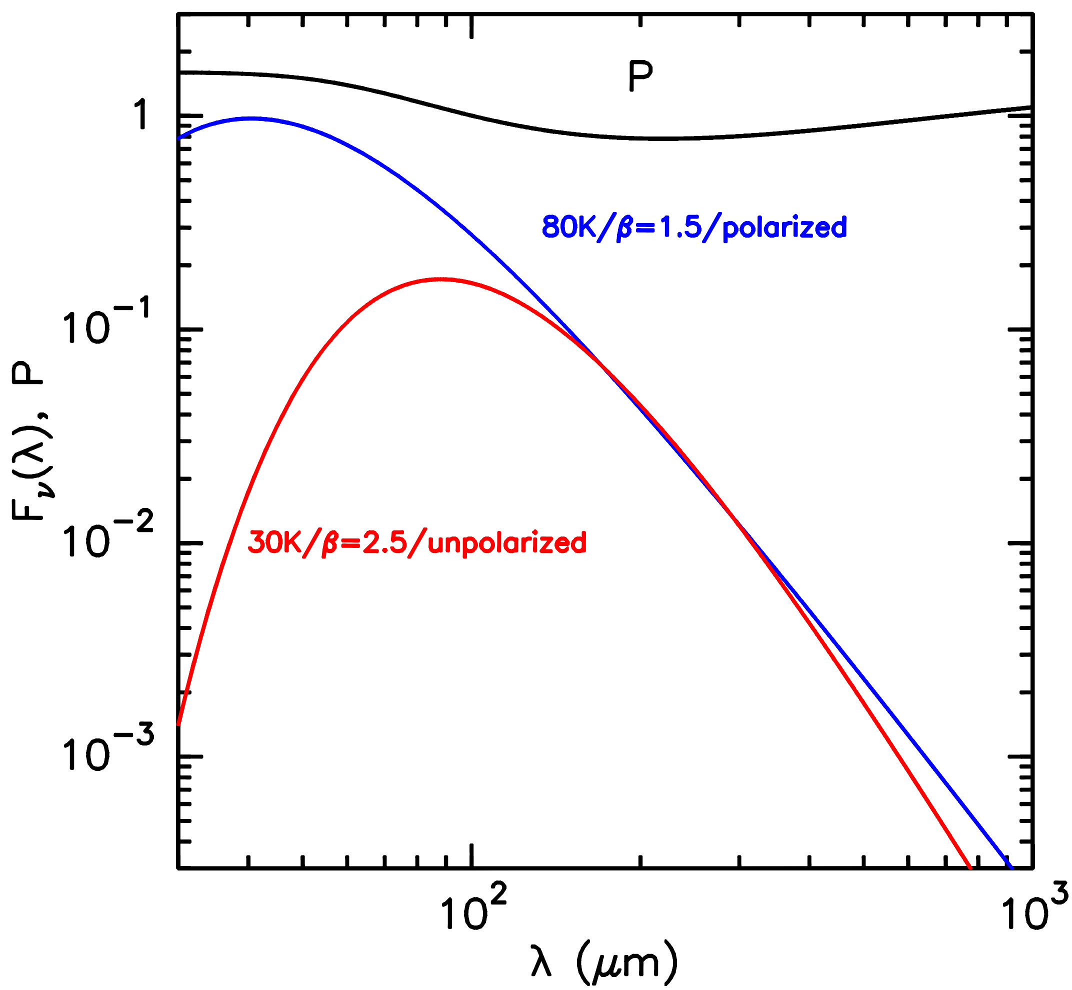
2a) 2+ temperature components, one polarized and one
not:




80K, polarized regions – near embedded stars
35K, unpolarized regions – deep in cloud, away from stars. ‘Bad’ grains.
10K polarized regions – cloud surfaces (?) [Not in original Hildebrand et al. (1999) model.]

# <u>Explanations for Dip in Polarization Spectrum</u>

2b) Combination of temperature and emissivity effects:




Evidence for anticorrelation of temperature and submillimeter β in Orion: Lis et al. (1998), ApJ 509: 299.

# Predictions

Hildebrand et al. (1999) suggest that grains exposed to UV/optical photons are better aligned. Resulting predictions:

1) Warmer lines of sight should have larger polarization.

   [Existing data: In Orion, weak correlation of P(100 $\mu$m) with $F_\nu$(100 $\mu$m)/$F_\nu$(350 $\mu$m); stronger correlation for P(350 $\mu$m). Seeing mostly 'good' grains at $\lambda$<=100 $\mu$m in clouds with OB stars?]

2) Optically thick clouds devoid of stars should have relatively low polarization.

3) Translucent clouds should have relatively large submillimeter polarization. If the graphite grains are unaligned and are warmer than the aligned silicate grains, then the far-IR polarization will be smaller. ($dP/d\lambda > 0$.)