PROTECTING OUR PIXELS:

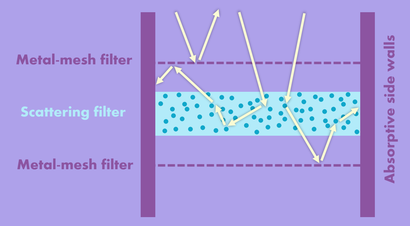
Characterization of aerogel scattering filters for astronomical telescopes

ALYSSA BARLIS[2], Stefan Arseneau[1], Charles L. Bennett[1], Thomas Essinger-Hileman[2], Haiquan Guo[3], Kyle R. Helson[2,4], Tobias Marriage[1], Manuel A. Quijada[2], Ariel E. Tokarz[5], Stephanie L. Vivod[5], Edward J. Wollack[2]

[1] Johns Hopkins University Department of Physics & Astronomy; [2] NASA Goddard Space Flight Center; [3] Universities Space Research Association; [4] The University of Maryland – Baltimore County; [5] NASA Glenn Research Center

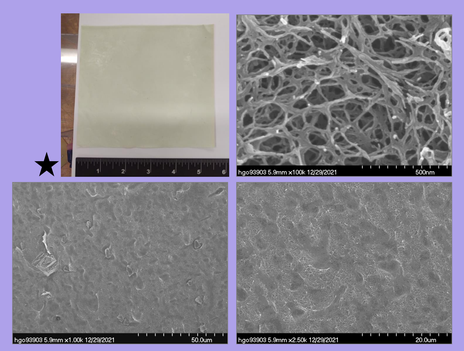
background

- Effective optical filtering **enables sensitive science detectors** by rejecting noise and thermal loading from out-of-band and stray light
- Combining scattering, absorbing, and reflecting filters produces robust optical filtration
- In the far-infrared & sub-mm regime, options are limited for wide-band, tunable infrared-blocking filters



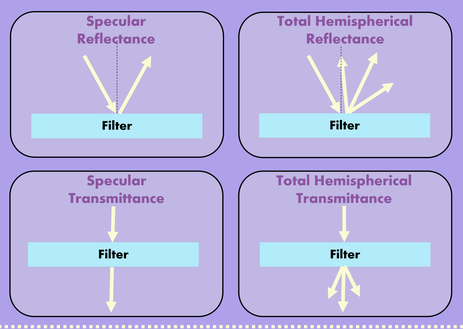
what's new?

- We incorporate scattering particles in a polymer aerogel base to produce a filter with a tunable cutoff frequency
- Polyimide aerogels are light, mechanically flexible, and have very low index of refraction (n ~ 1) -- **no anti-reflection coatings necessary!**



characterization

To fully characterize filter performance, we measure these optical properties:



spectrometer facilities:

Bruker IFS 125HR

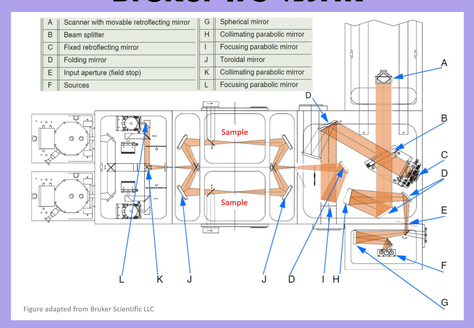
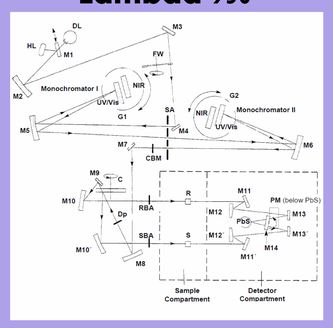
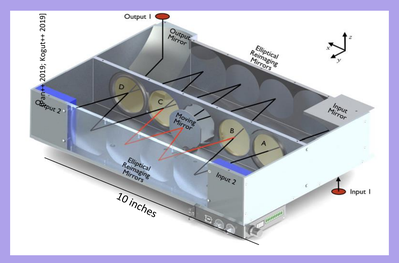


Figure adapted from Bruker Scientific LLC

PerkinElmer Lambda 950

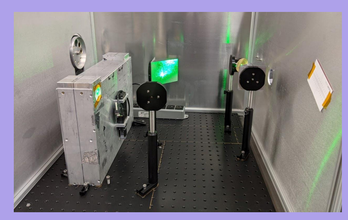


In development: Long-wavelength Fourier Transform Spectrometer (FTS) testbed

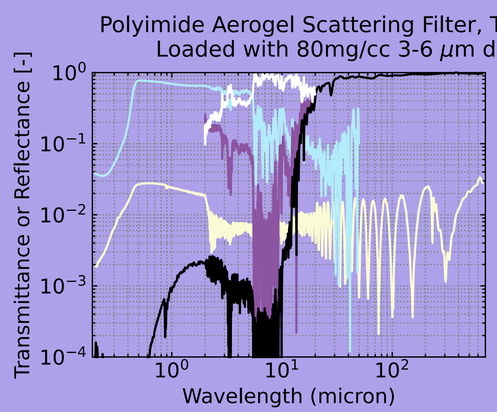


Signal path:

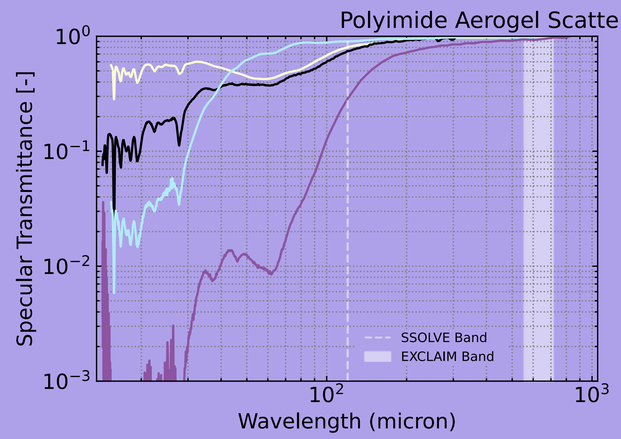
Blackbody Source → FTS → Coupling Optics → Sample → Detector



results



Because the loaded aerogel filters scatter heavily, we must measure the total hemispherical reflectance and transmittance to understand their optical properties.



We have demonstrated aerogel filter formulations targeted for EXCLAIM & SSOLVE instruments with:

- ✓ Desired cutoff frequency
- ✓ Near-unity in-band transmittance
- ✓ High out-of-band rejection

References

Essinger-Hileman et al., "Aerogel scattering filters for cosmic microwave background observations," Applied Optics, vol. 59, issue 18, p. 5439 (2020).
Meador et al., "Mechanically strong, flexible polyimide aerogels cross-linked with aromatic trimine," ACS Appl. Mater. Interfaces 4, 536–544 (2012).
Pan et al., "A Compact Millimeter-Wavelength Fourier-Transform Spectrometer," Vol. 58, Issue 23, pp. 6257-6267 (2019).
Kogut, Fixsen, "Systematic error cancellation for a four-port interferometric polarimeter,"Journal of Astronomical Telescopes, Instruments, and Systems, Volume 5, id. 024008 (2019).

See also: Poster 12190-114