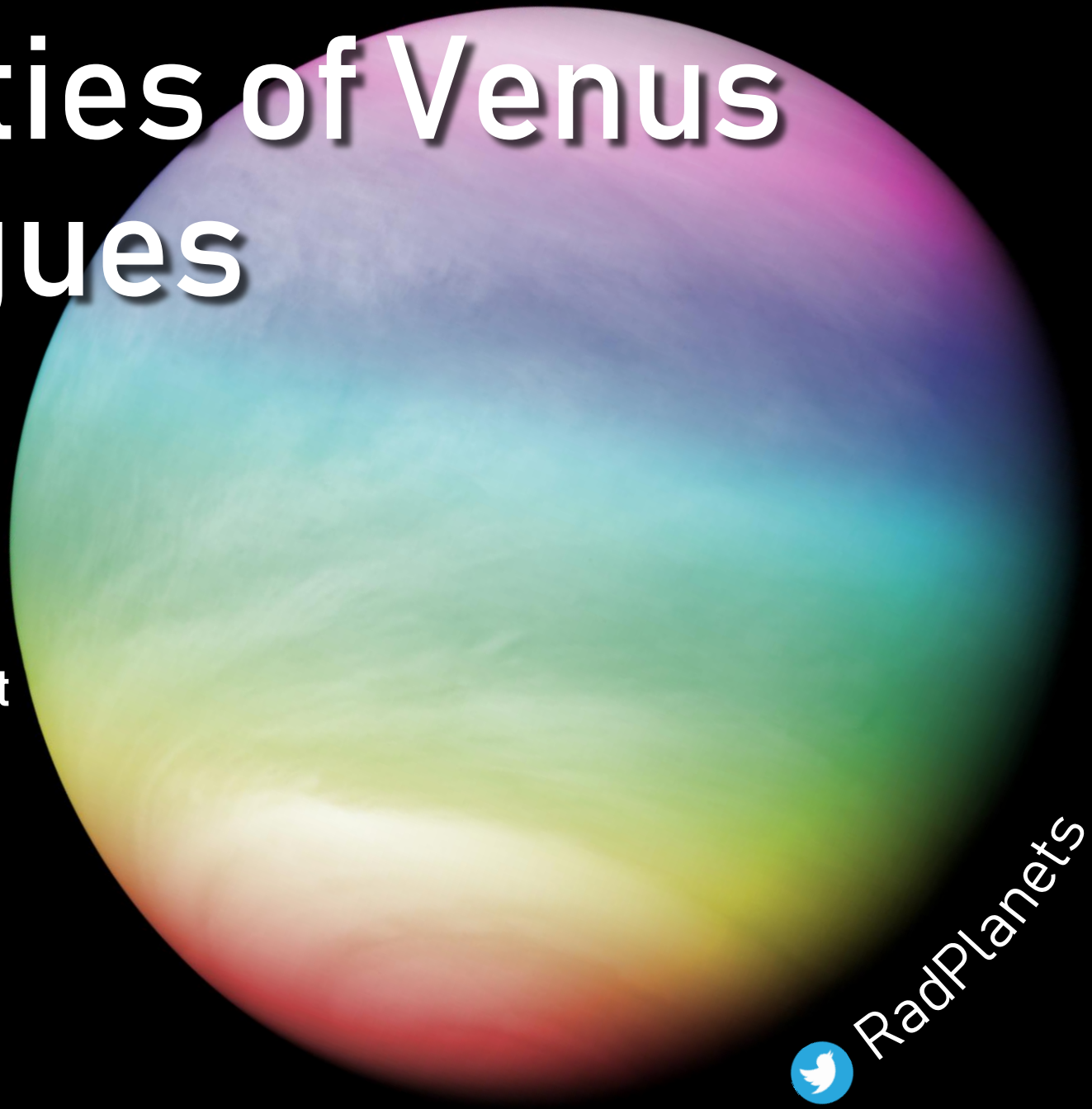
Optical properties of Venus aerosol analogues



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Johns Hopkins University

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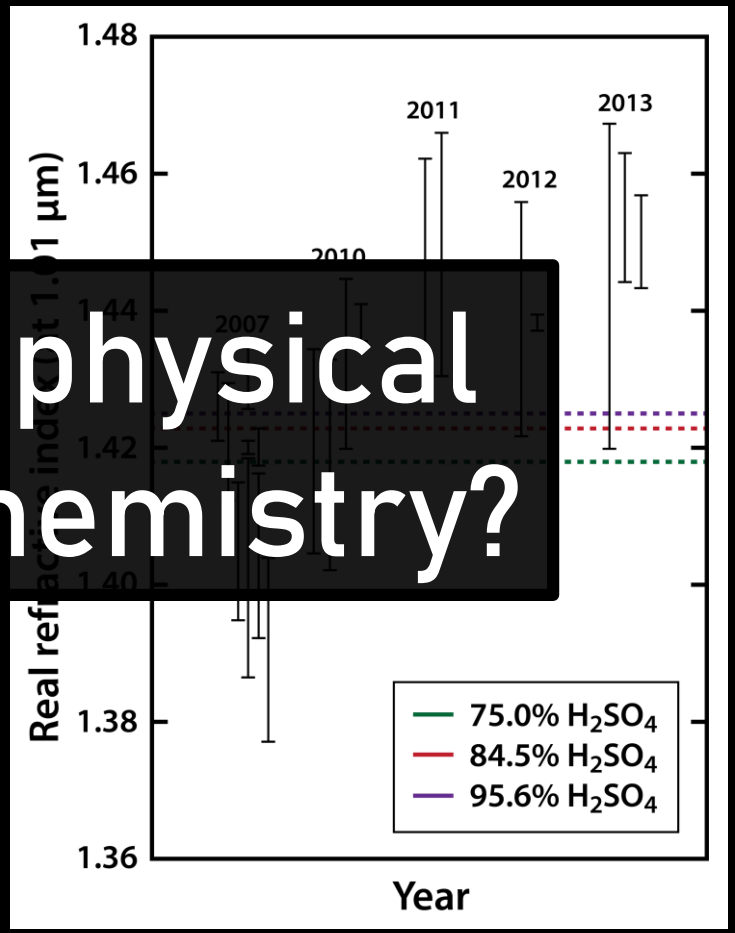
We can determine physical properties of the clouds from spacecraft and ground-based observations.

Cloud morphology:

Refractive index:



How do changes in aerosol physical properties relate to their chemistry?

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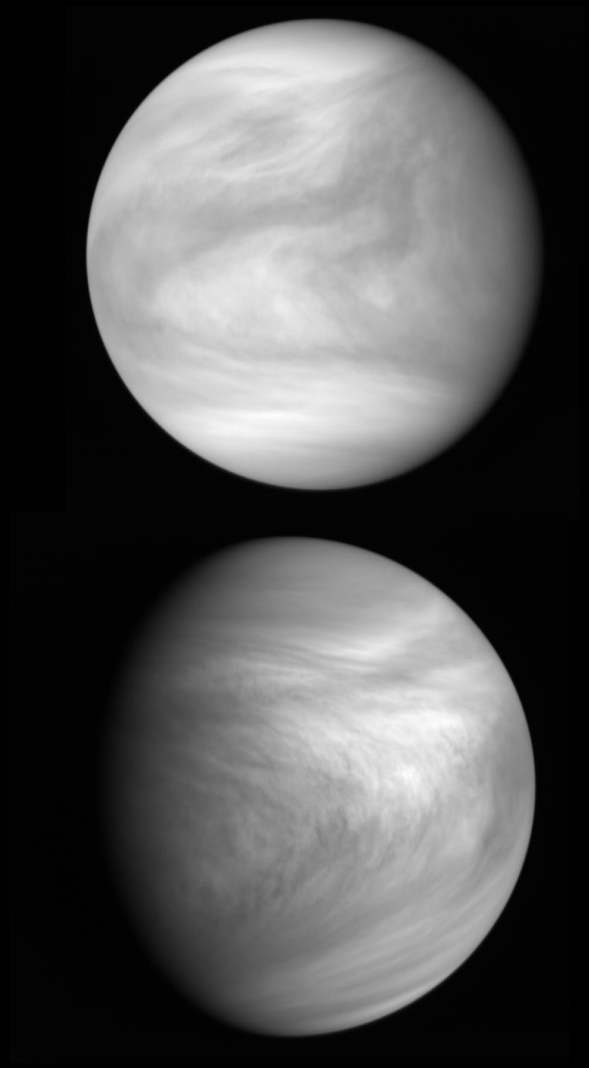
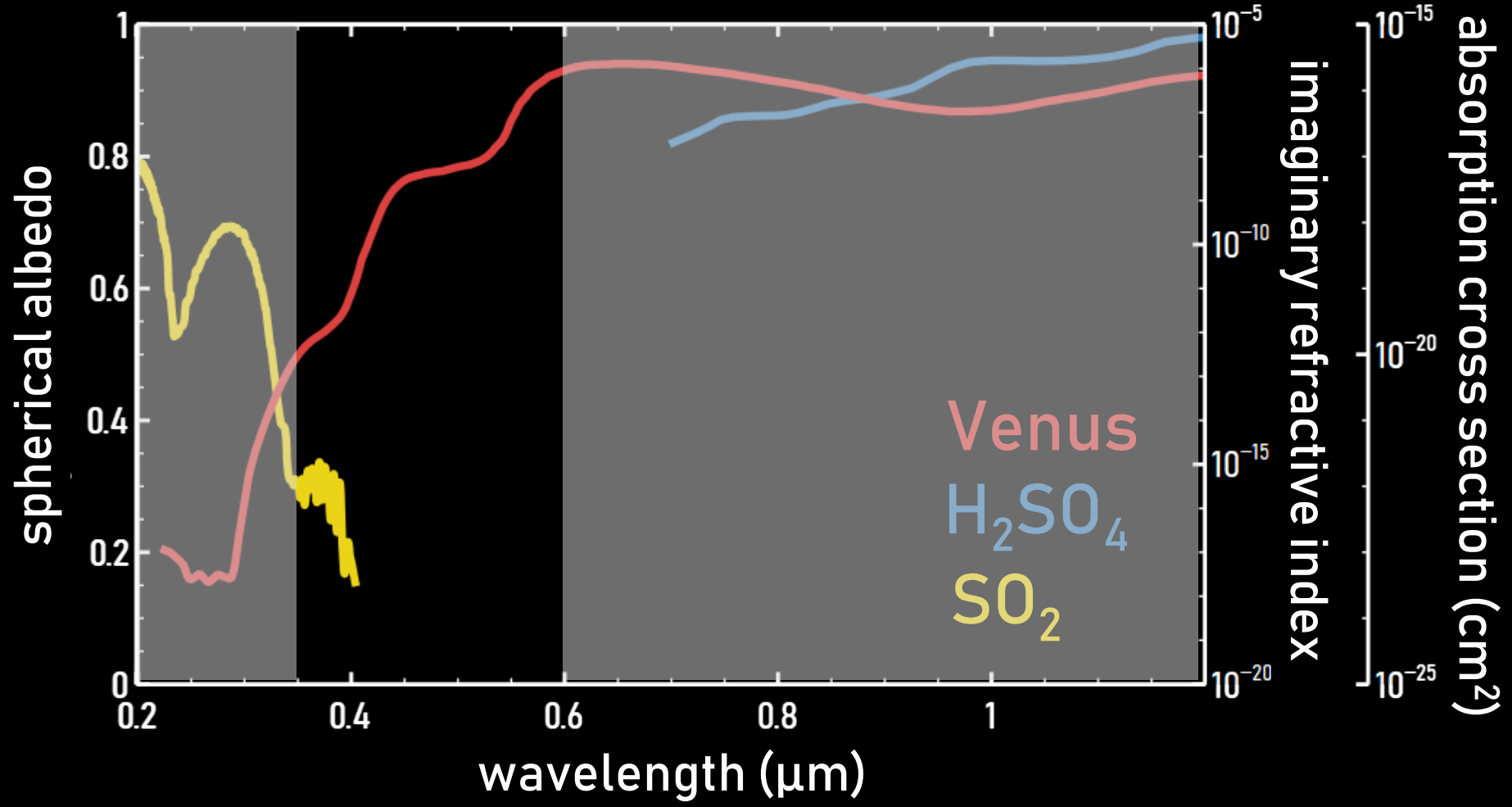
Akatsuki - JAXA

Modified from Rossi (2018)

The best example of this is Venus' "unknown absorber."





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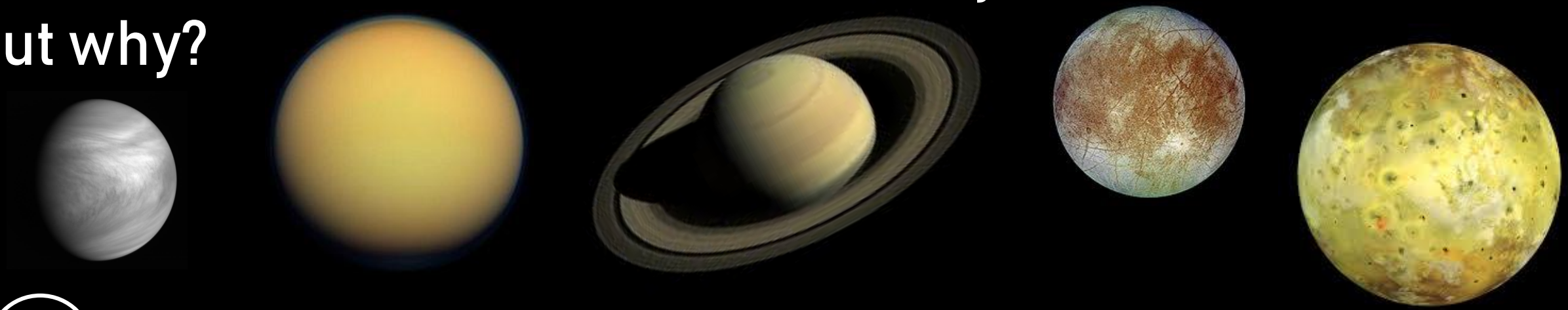
Unknown UV absorbers exist on many other bodies, too. But why?



1. Absorptions are often very intense, difficult to measure.
2. Absorptions are broad and not diagnostic of composition.
3. Scattering effects cannot be neglected.

We need to know optical constants for cloud materials…

…to determine the nature of the unknown absorber(s).

…to effectively model radiative transfer in the clouds.

…to interpret chemical changes within the clouds.

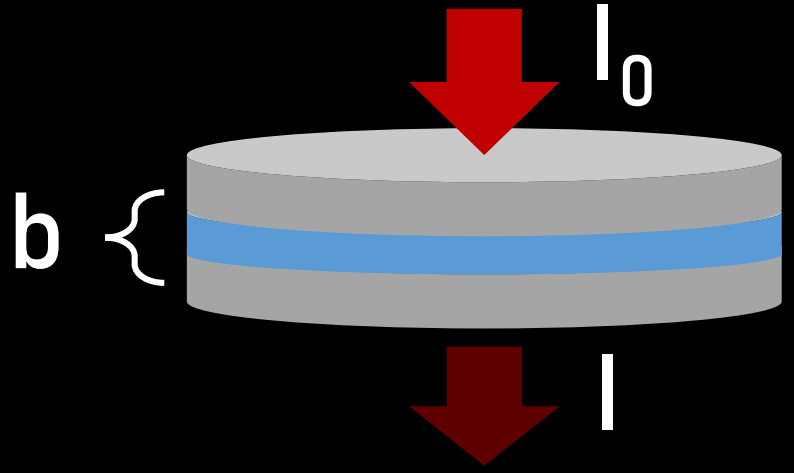
…to link cloud chemistry and gas chemistry.

…to accurately determine surface properties.

My goal is to create a library of optical constants for proposed cloud species at a variety of temperatures and concentrations, from UV to IR wavelengths.

We can calculate optical constants for materials from laboratory spectra (if a few other parameters are known).

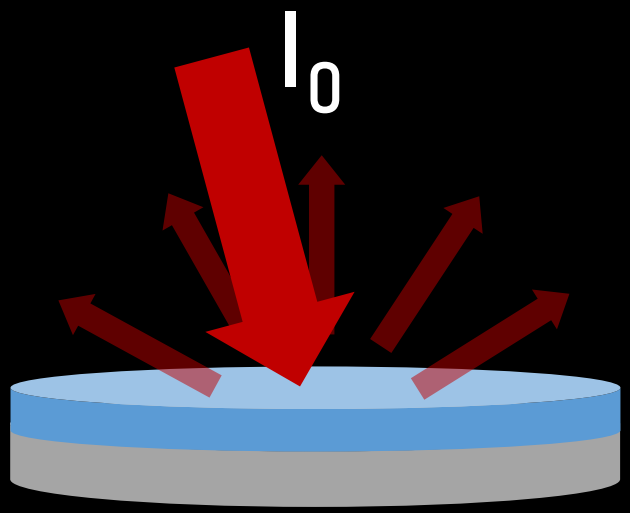
Transmission (thin film):



$$A = \log[I / I_0]$$

$$k \propto bA$$

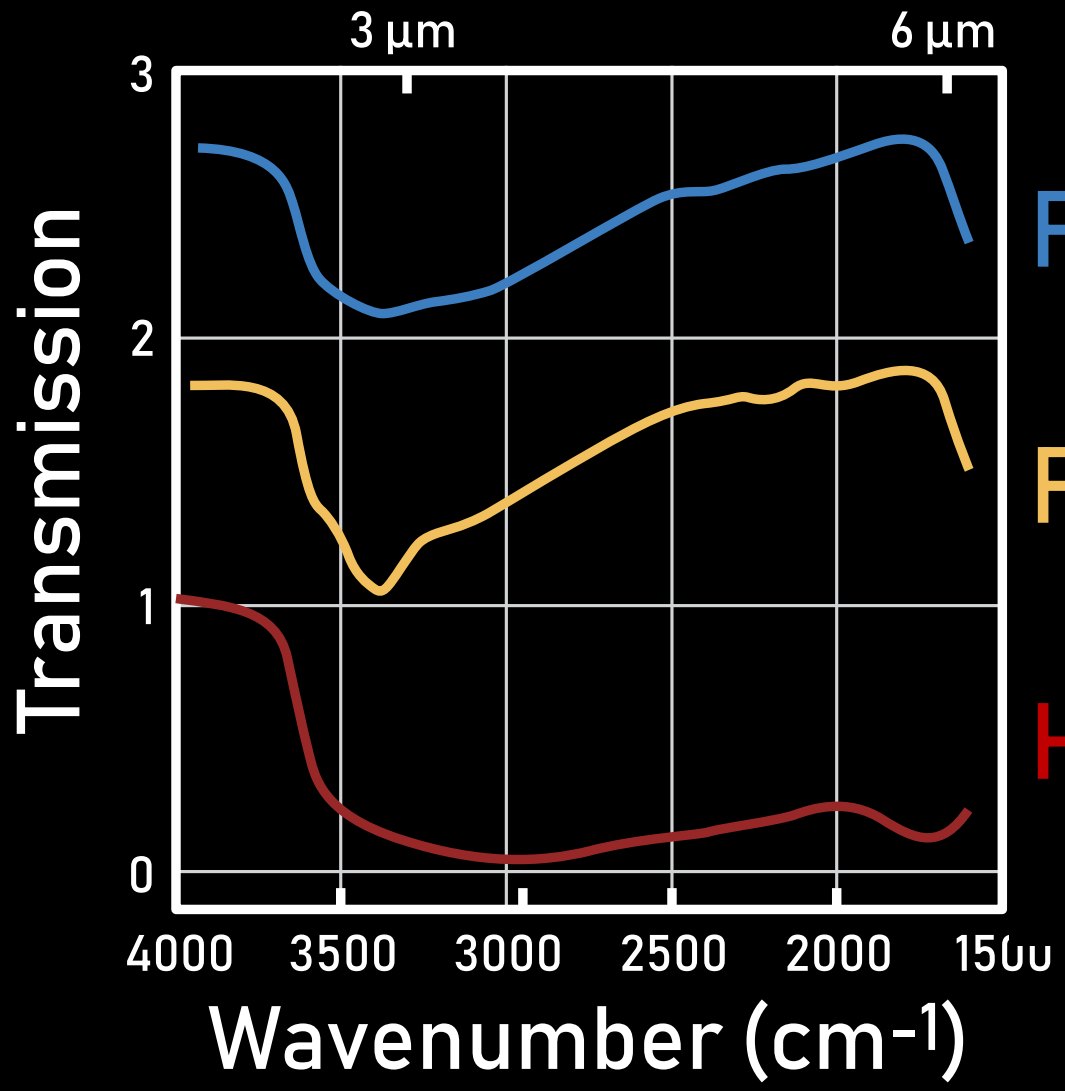
Diffuse reflection:



$$R_h = \iint I(\theta, \phi)\, d\theta\, d\phi / I_0$$

$$k \propto \text{(it's complicated)}$$

Infrared absorptions of iron chloride overlap with those of sulfuric acid.



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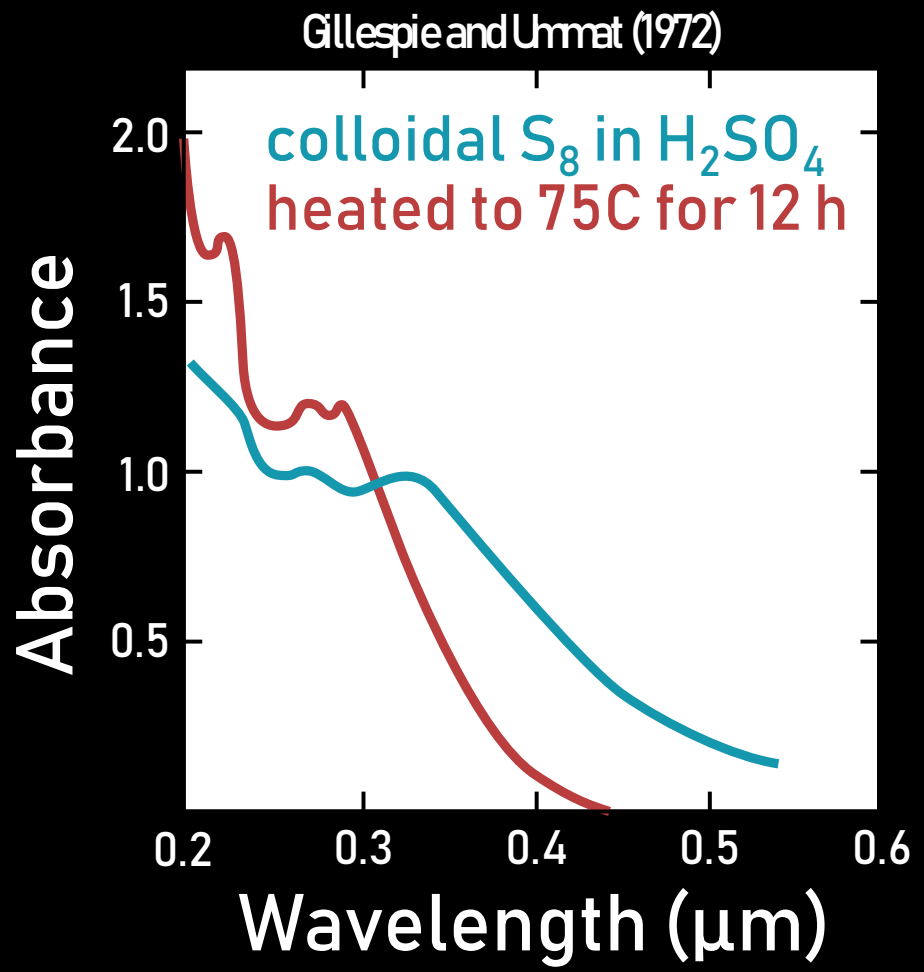
There is still a lot more work to do!

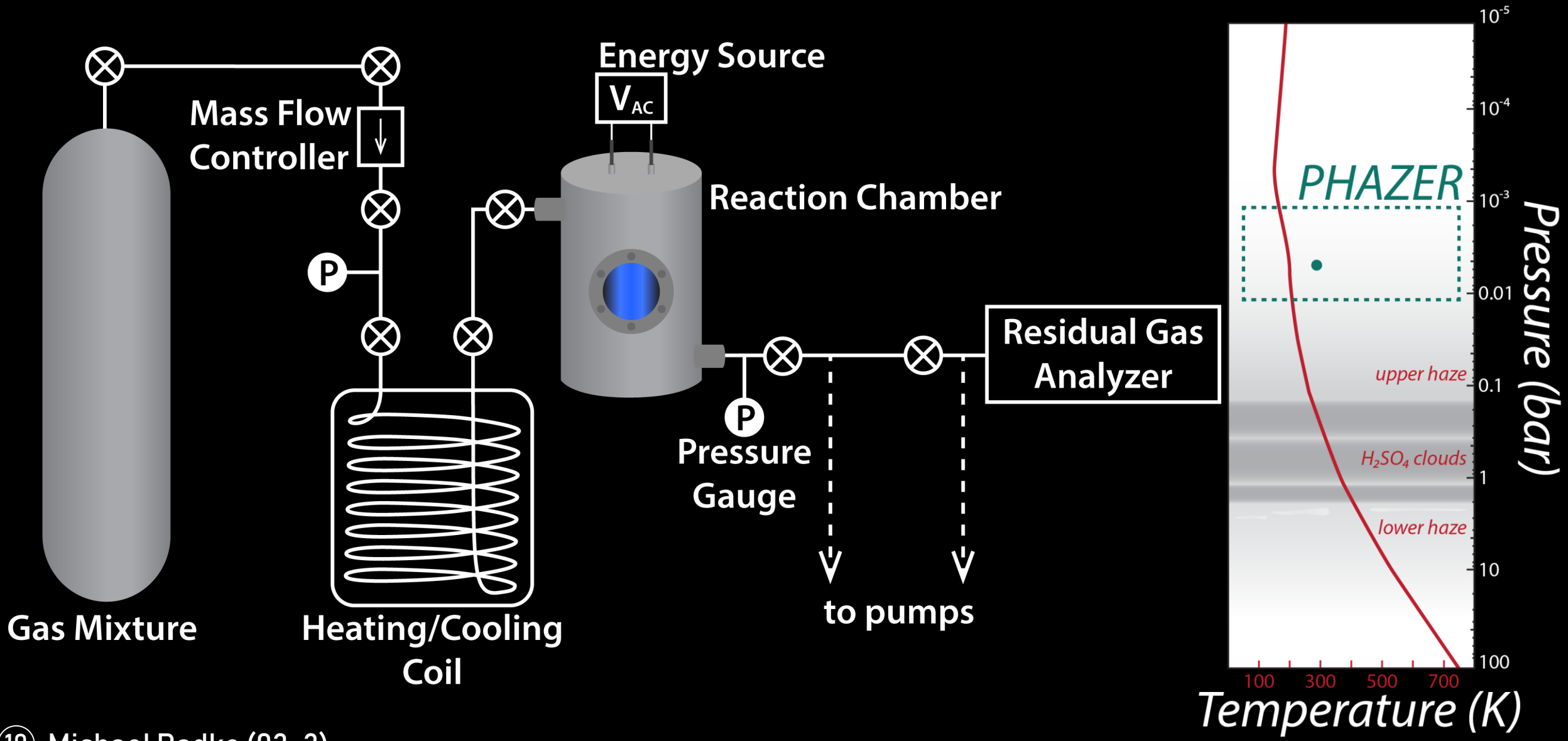
Reproducing old results...



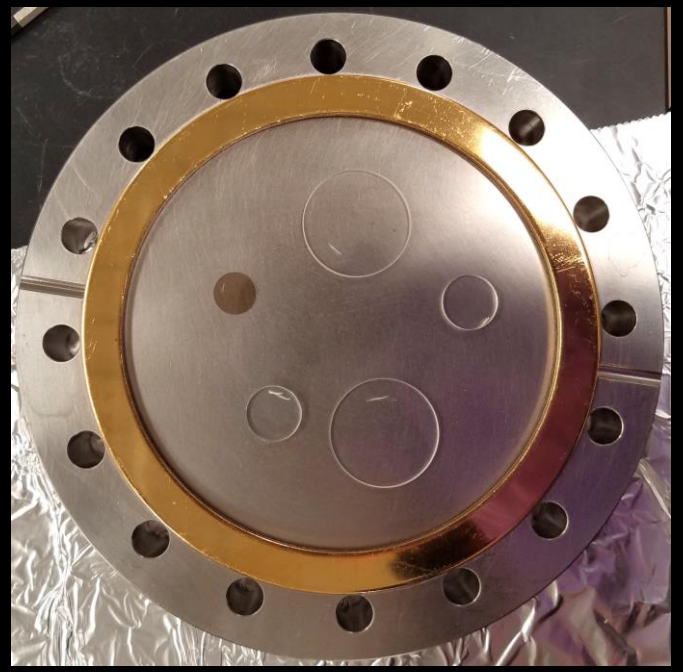
...and generating new ones!

basalt in H_2SO_4 (1 → 14 days)

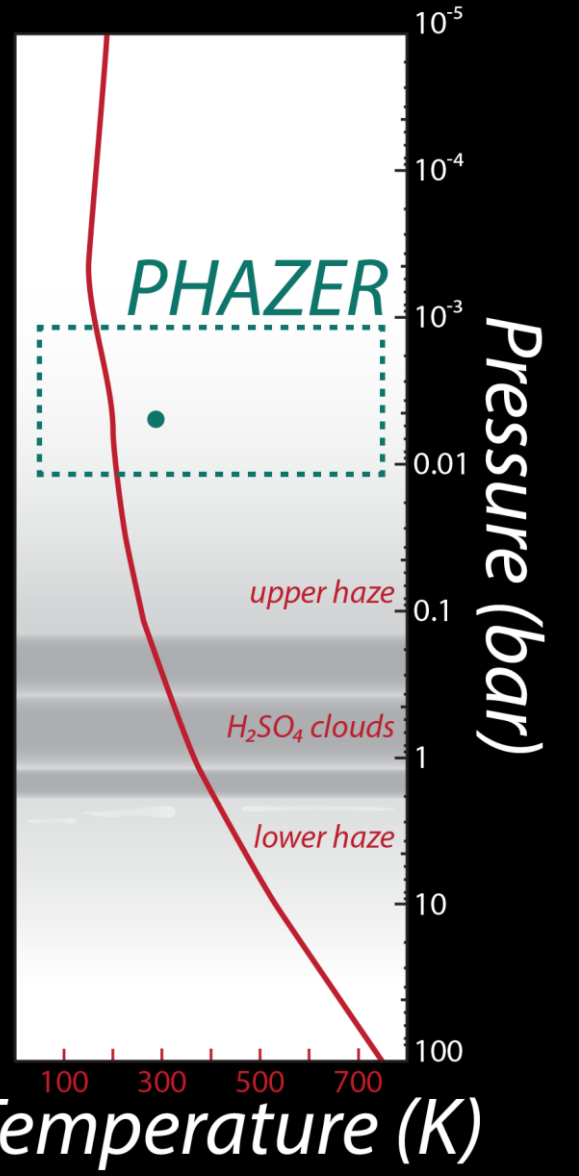
Hörst Lab can generate Venus analogue aerosol at JHU.



Hörst Lab can generate Venus analogue aerosol at JHU.

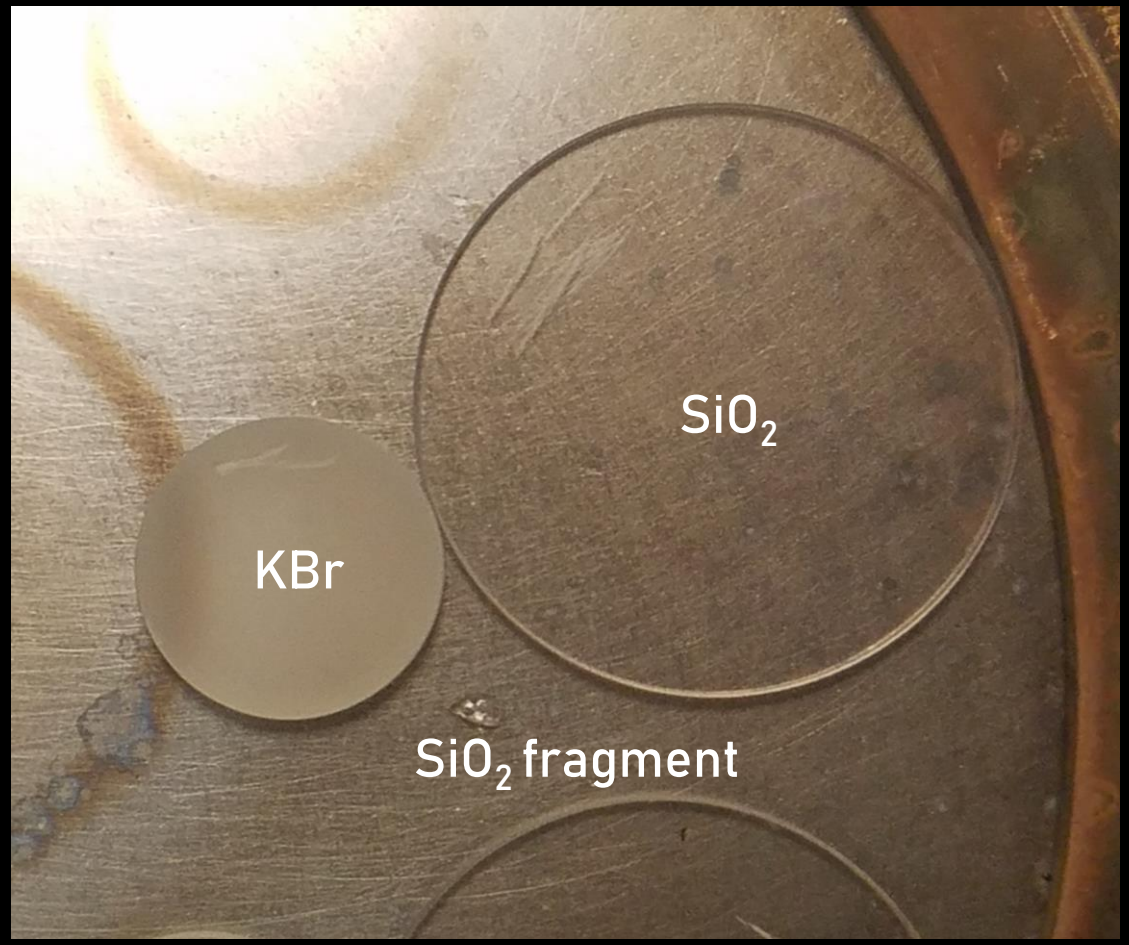


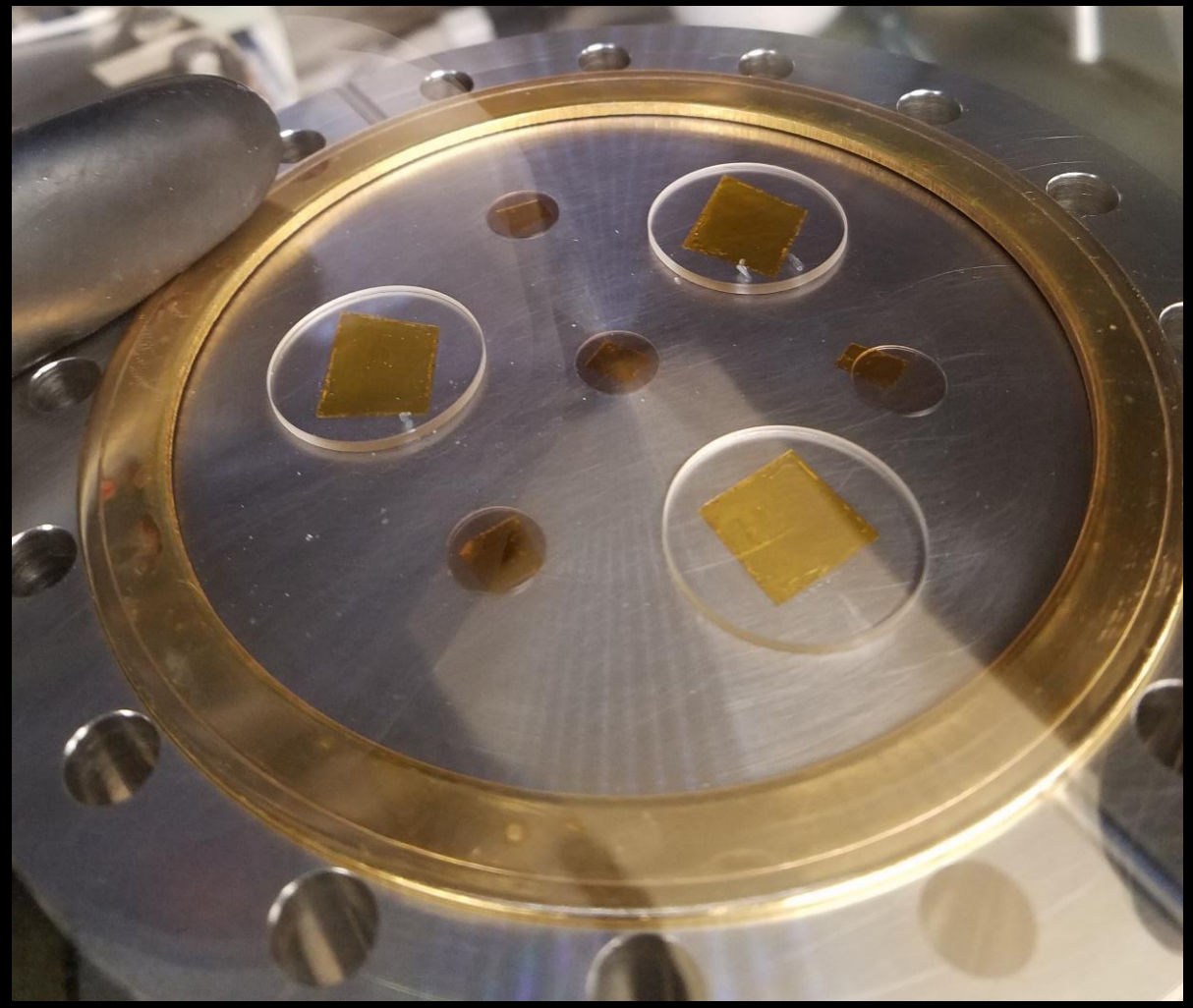
Gas composition: 0.02 to 2% SO_2 in CO_2
Temperature: 294 K (70 °F)
Energy source: UV lamp or plasma



Hörst Lab can generate Venus analogue aerosol at JHU.

And I plan to measure their optical properties, too.





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Takeaways:

- It is difficult to determine cloud chemistry remotely.
- Optical constants must be used to accurately model clouds, but data do not yet exist for relevant compounds.

More to come…

- UV-Vis-IR optical constants of proposed cloud species.
- More photochemistry experiments!