中央研究院
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Properties of the FU Ori disk within the inner 10 au radii

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A. Kospal, M. Takami, E. I. Vorobyov, Z. Zhu

Why Studies Inner 10 au?

1. The burst has lasted for almost **one century**.
   In terms of **dynamical (orbital) timescale**, this region (or larger region) is likely relevant to gas feeding.

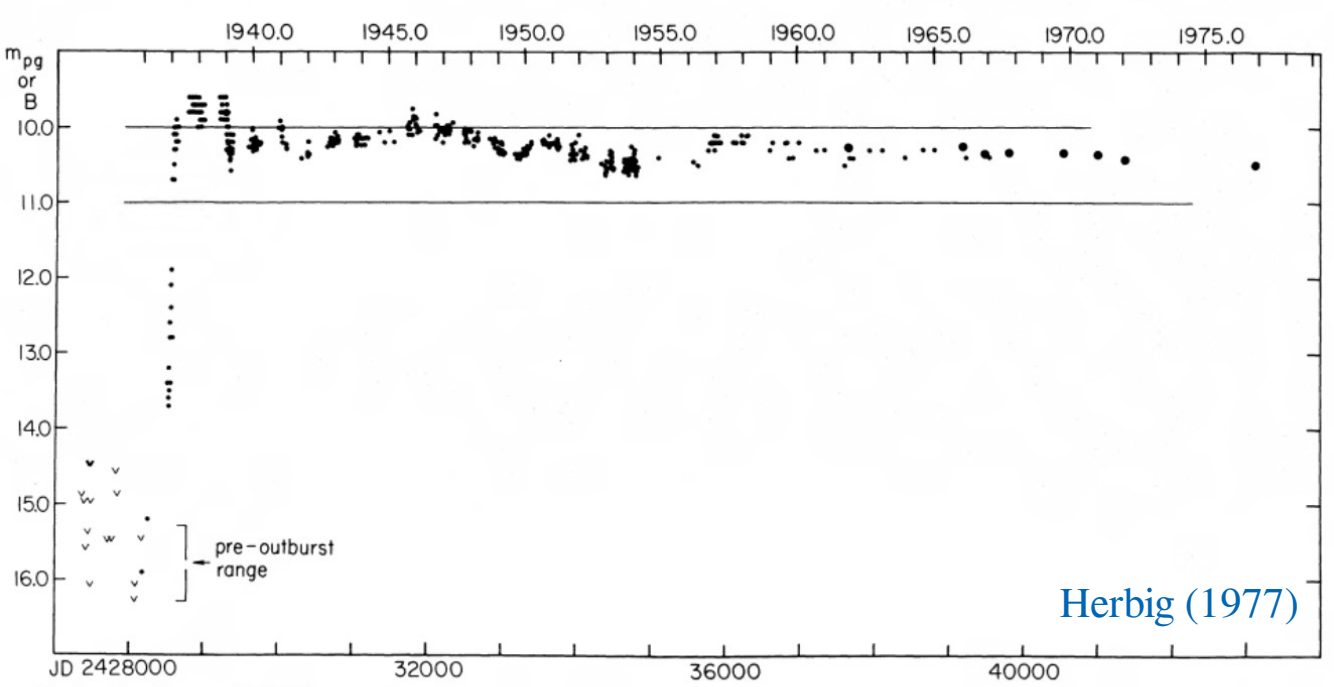

FIG. 1.—The photographic/*B* light curve of FU Ori through 1976. Small points represent photographic observations by Hoffleit (1939), Wachmann (1954), and Weber (1956, 1961, 1964, 1967). The larger points are photoelectric measures of *B* by Smak (Herbig 1966), Mendoza (1968), Dibai and Zaitseva (1968), Lee (1970), Lee and Low as quoted by Rieke *et al.* (1972), Landolt (1972), Schweitzer (1975, private communication), and Stone (unpublished).

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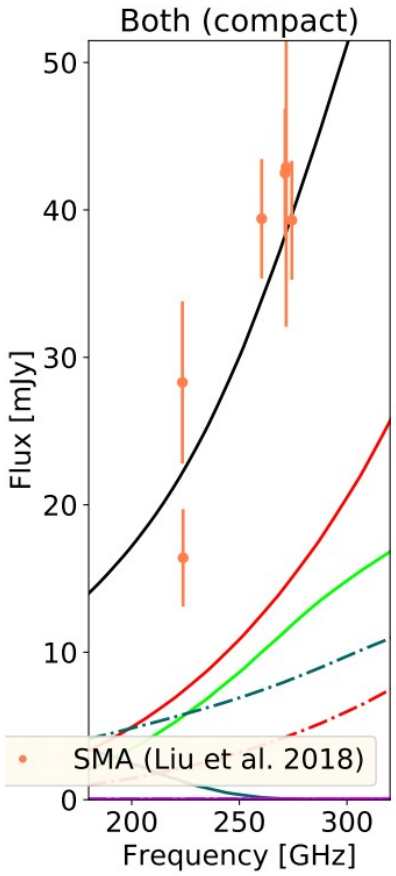

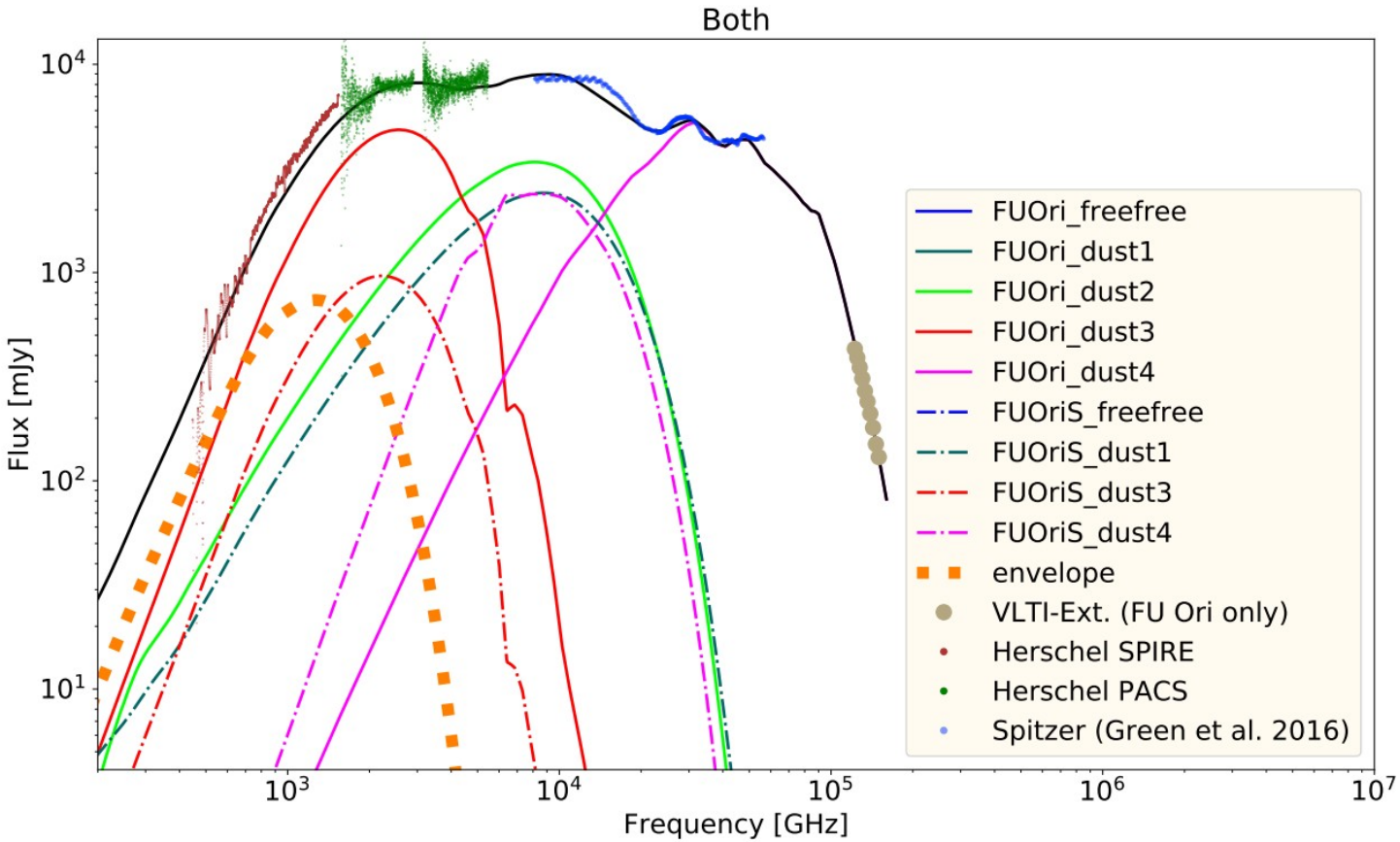

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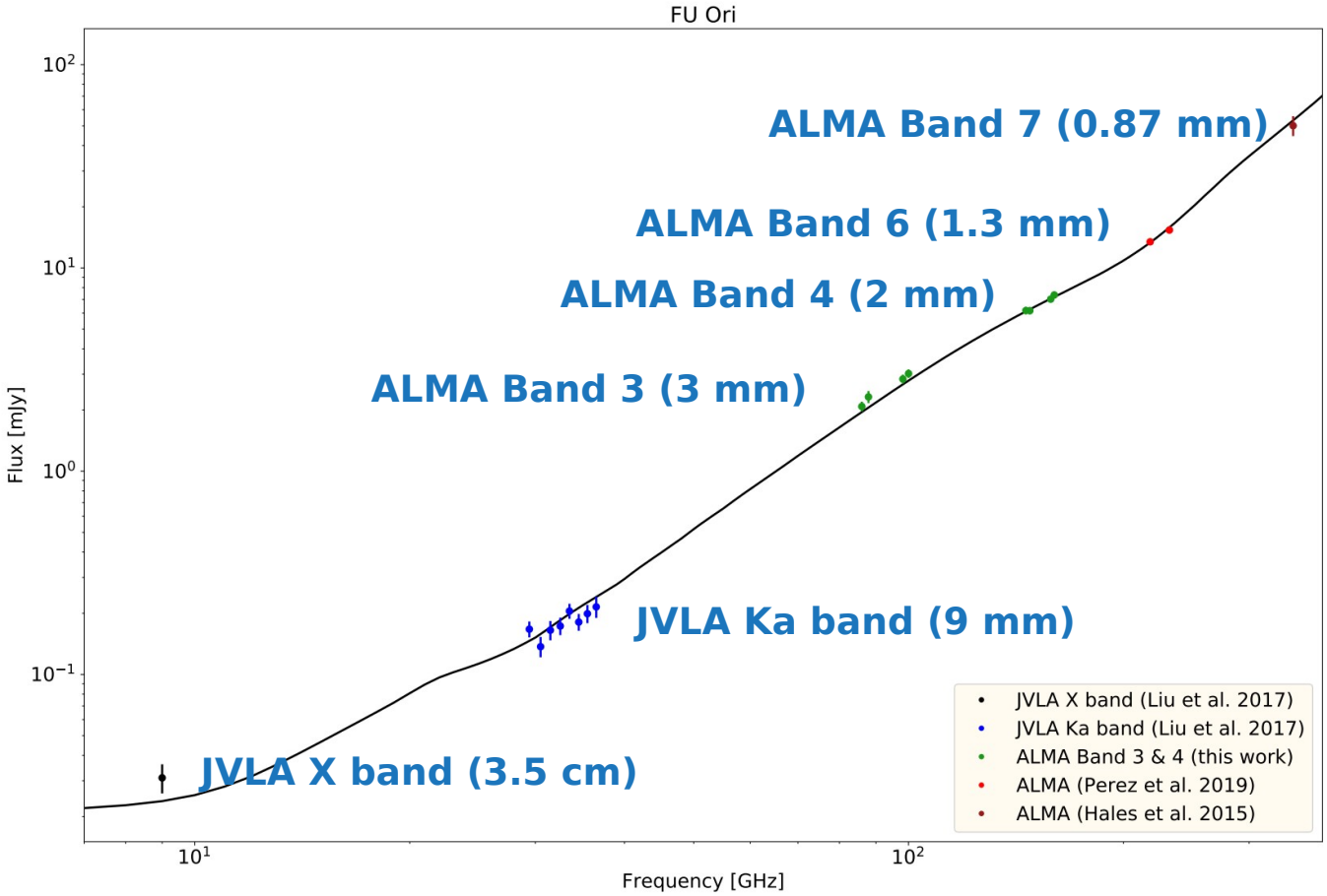

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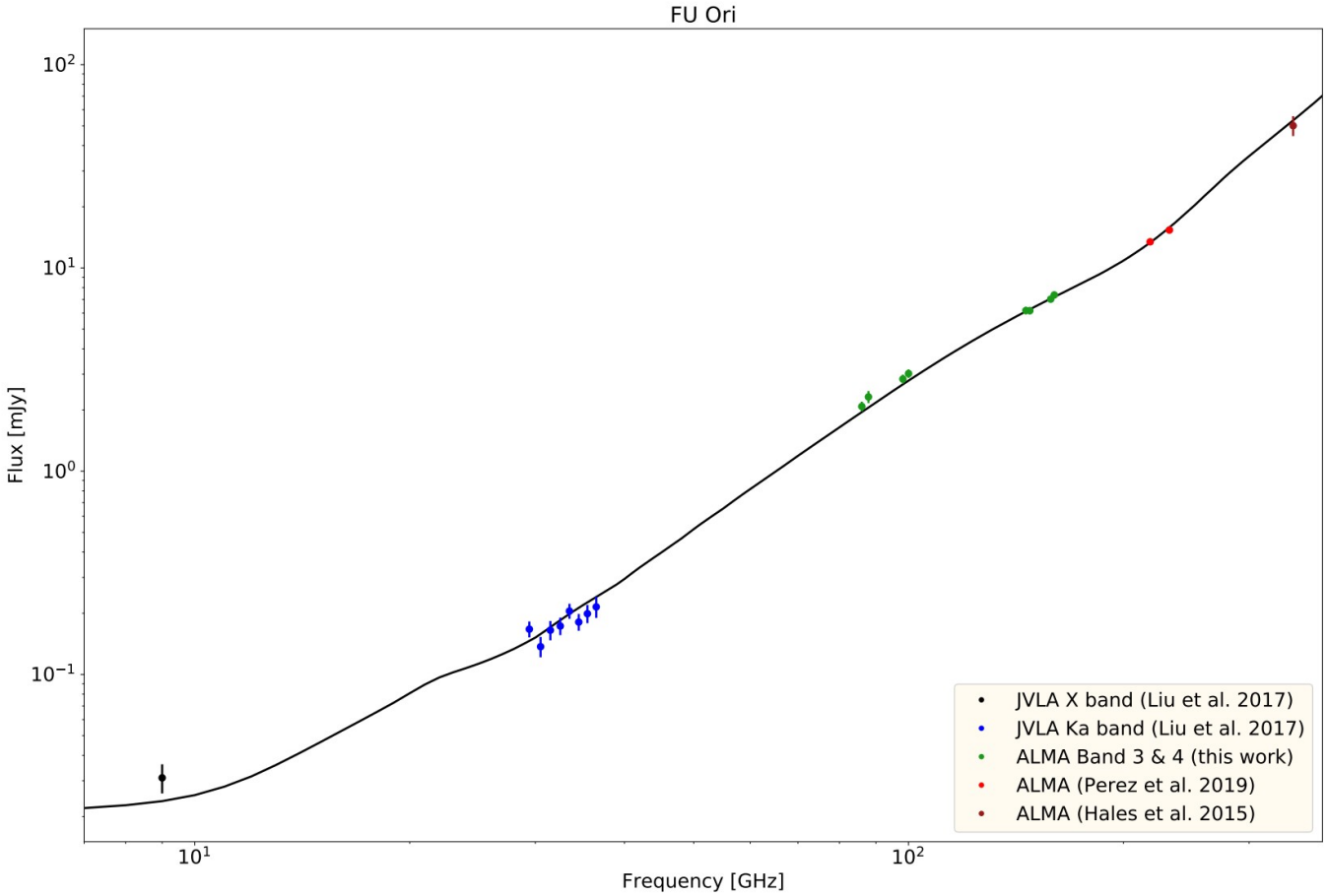
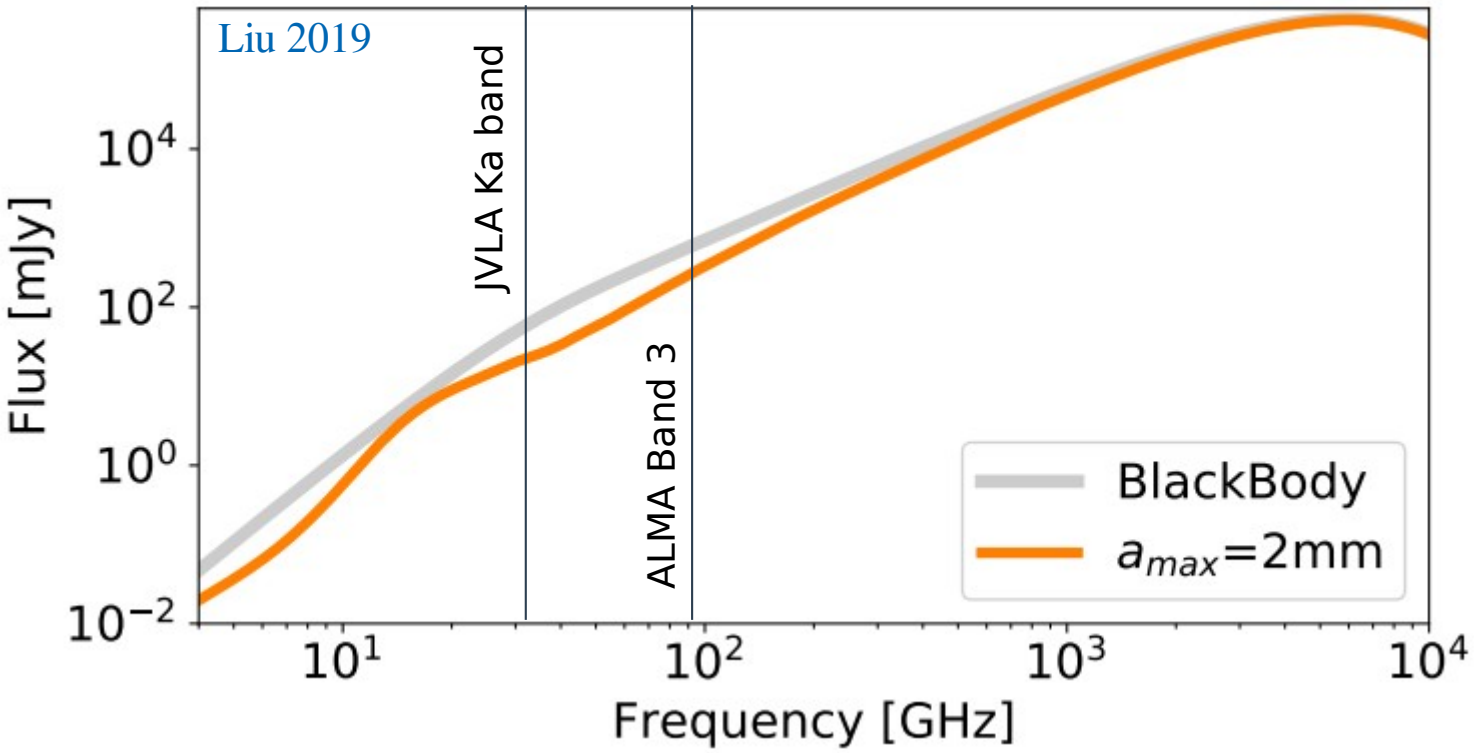


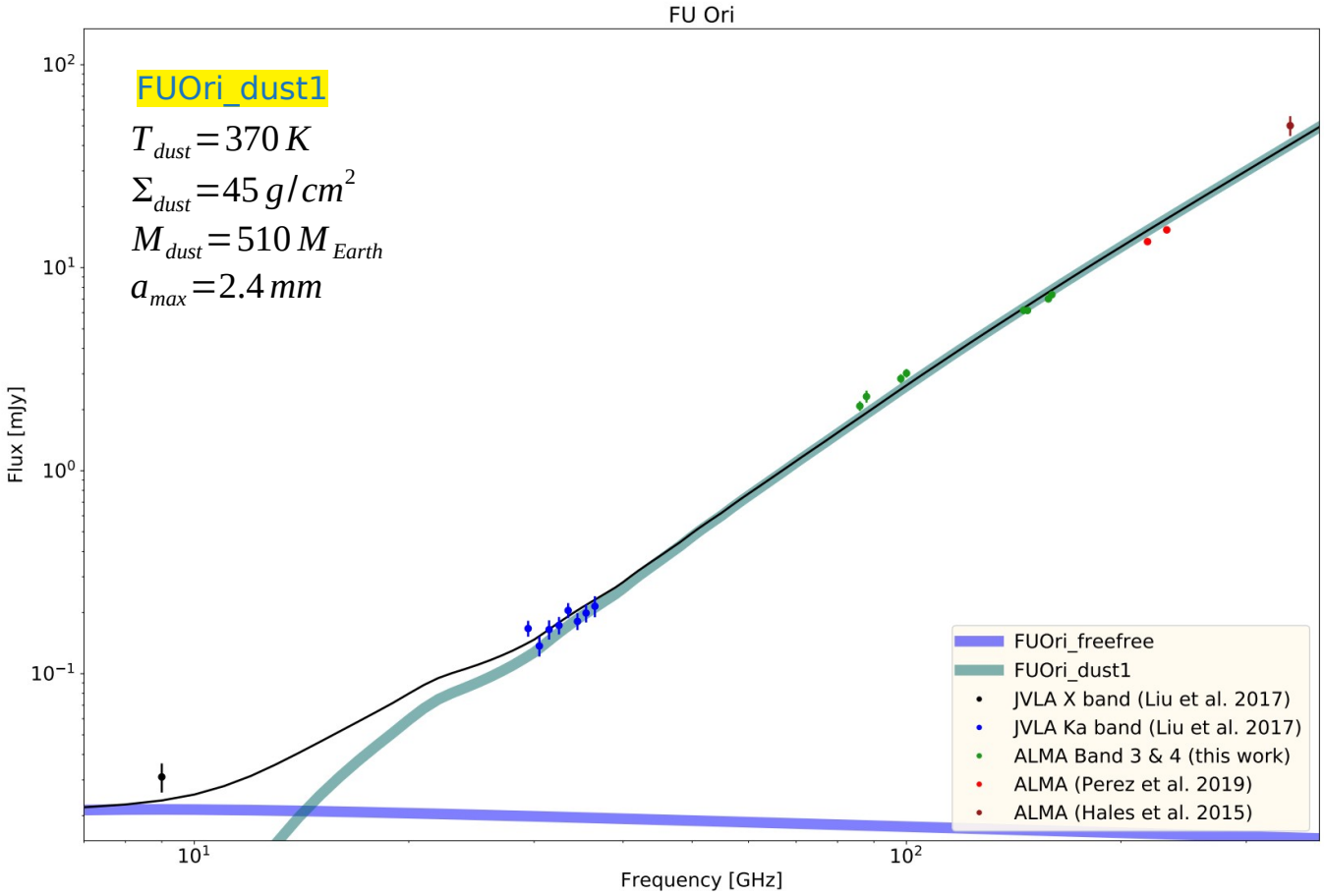
Dust scattering opacity always needs to be self-consistently considered

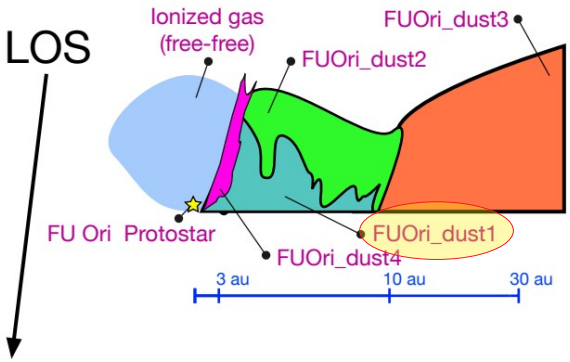
Otherwise, you can overestimate grain sizes by 2-3 orders of magnitudes; and underestimate dust masses by 1-2 orders of magnitude



Requires a very optically thick disk of ~10 au to explain the observed 9 mm (33 GHz) fluxes

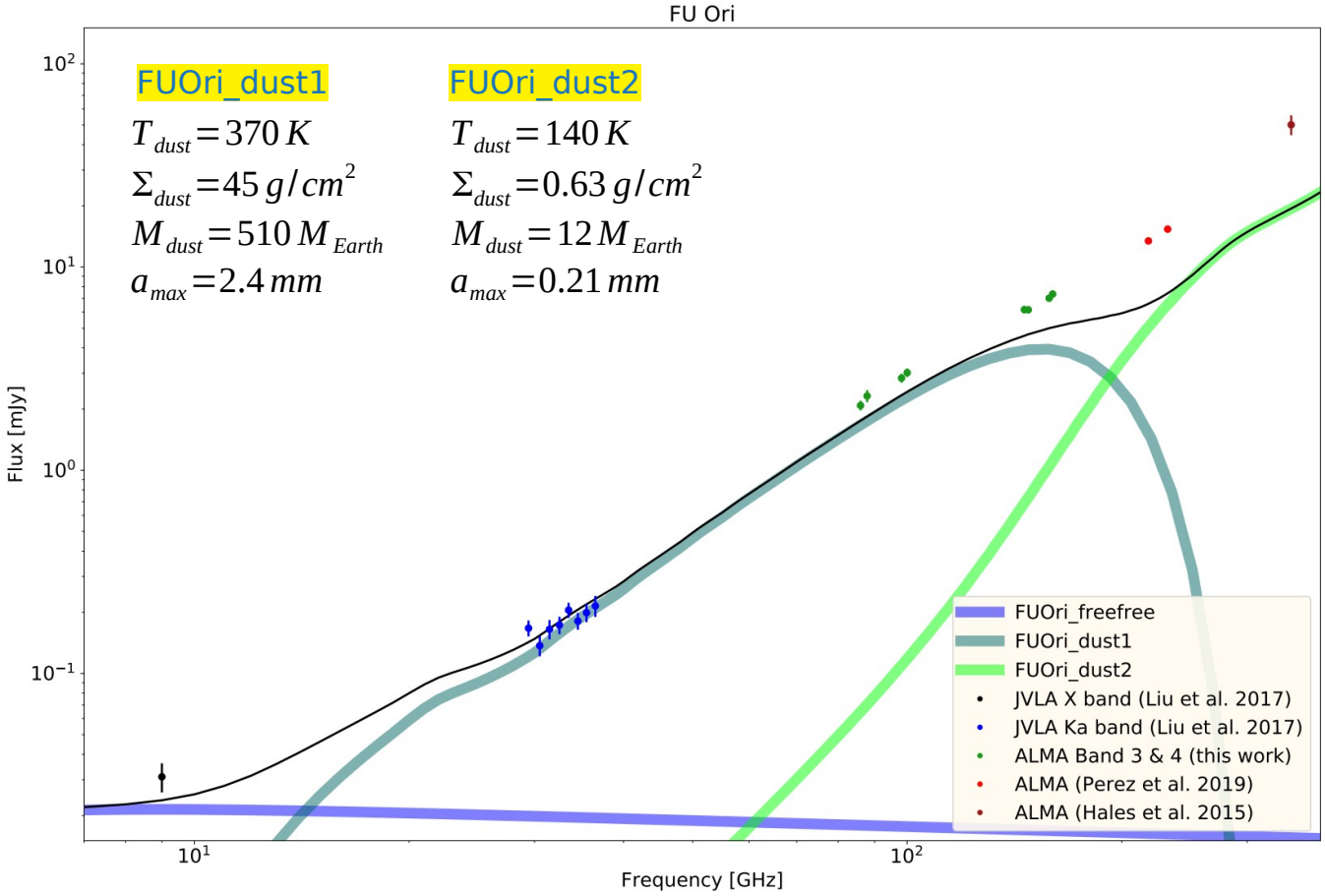
Liu et al. (2019)

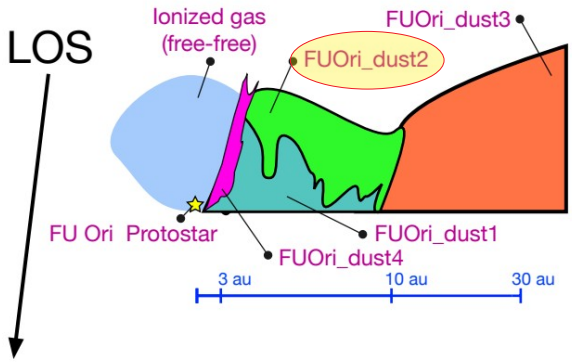




Need to obscure the 10 au disk with a lower temperature atmosphere to avoid excess at high frequency

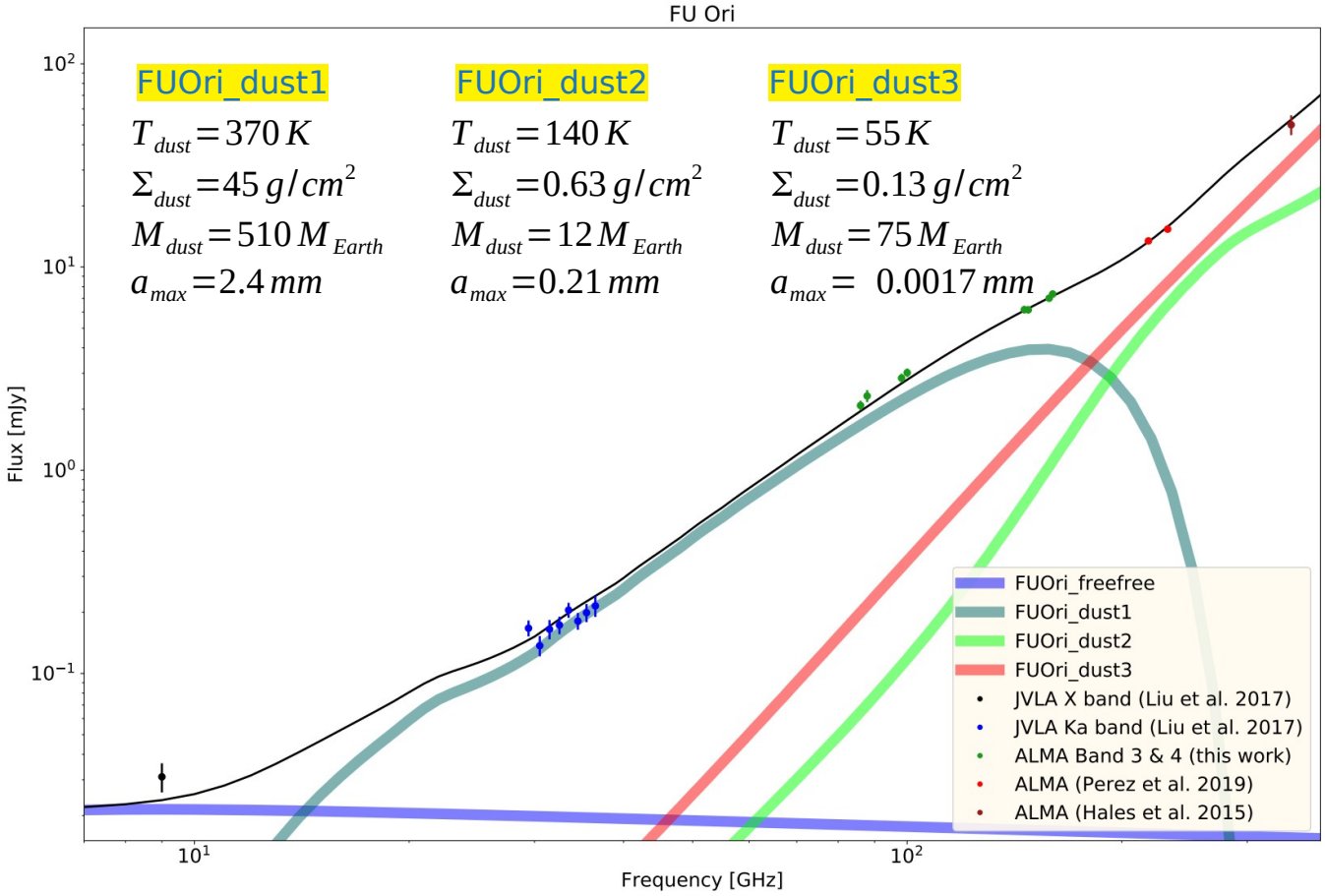
Liu et al. (2019)

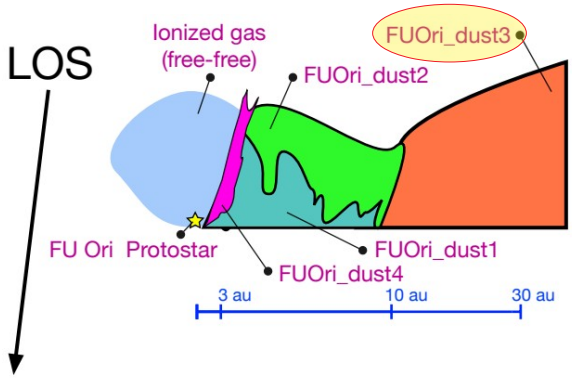




Including an optically thin and spatially extended outer disk to complement high frequency emission with a steep spectral slope

Liu et al. (2019)





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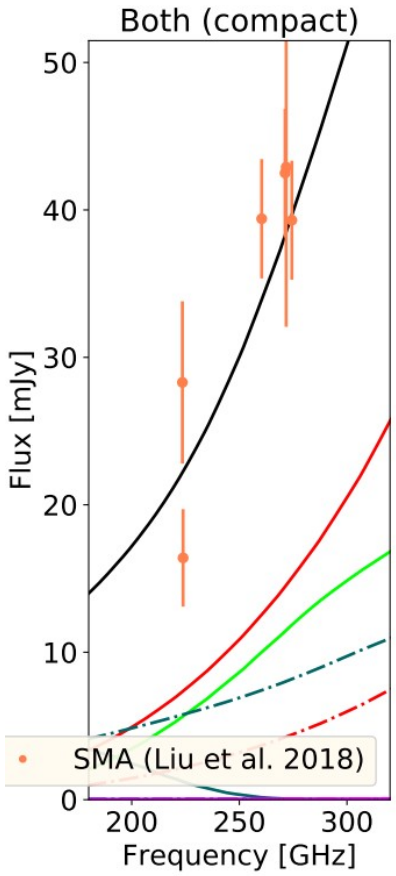

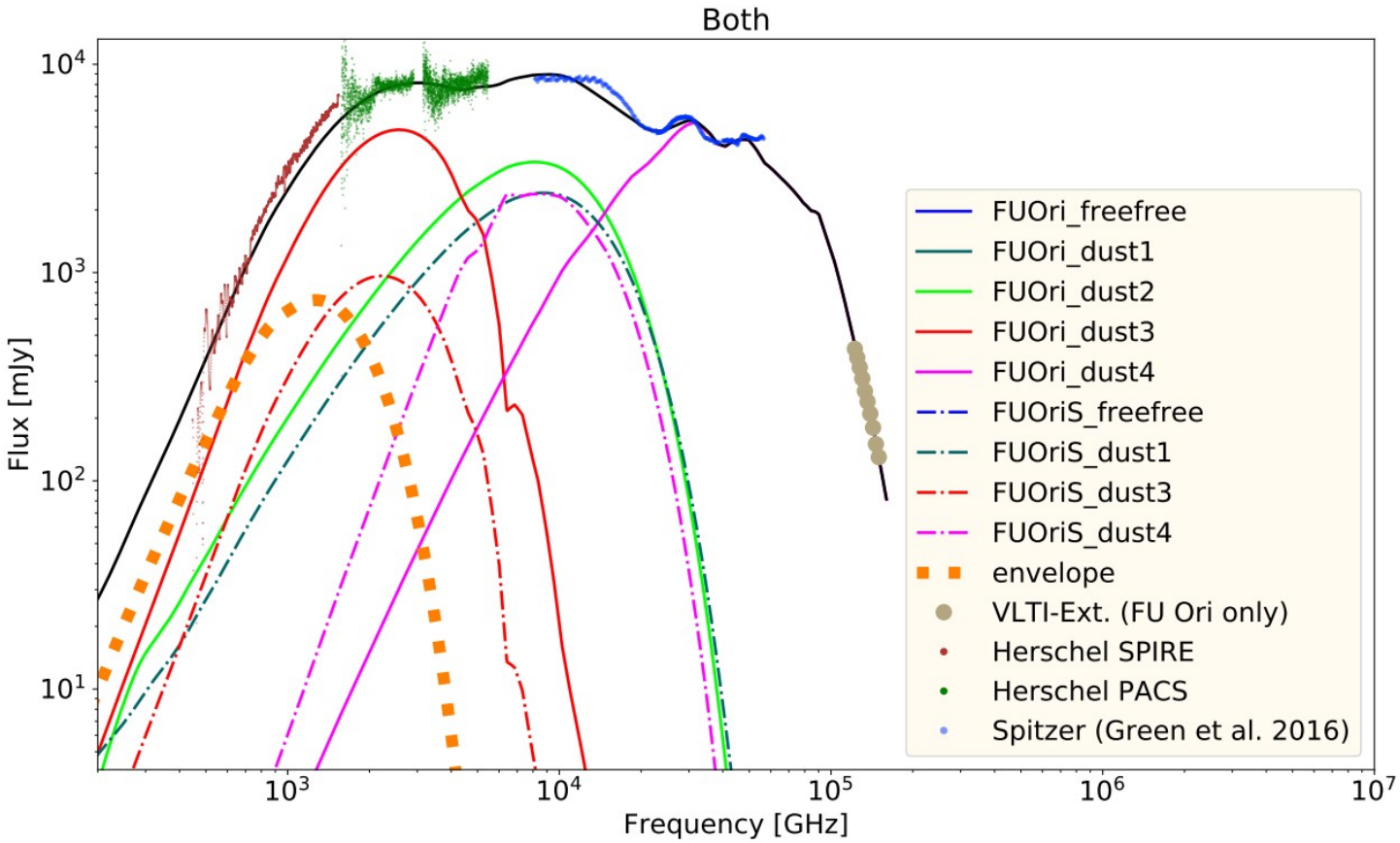

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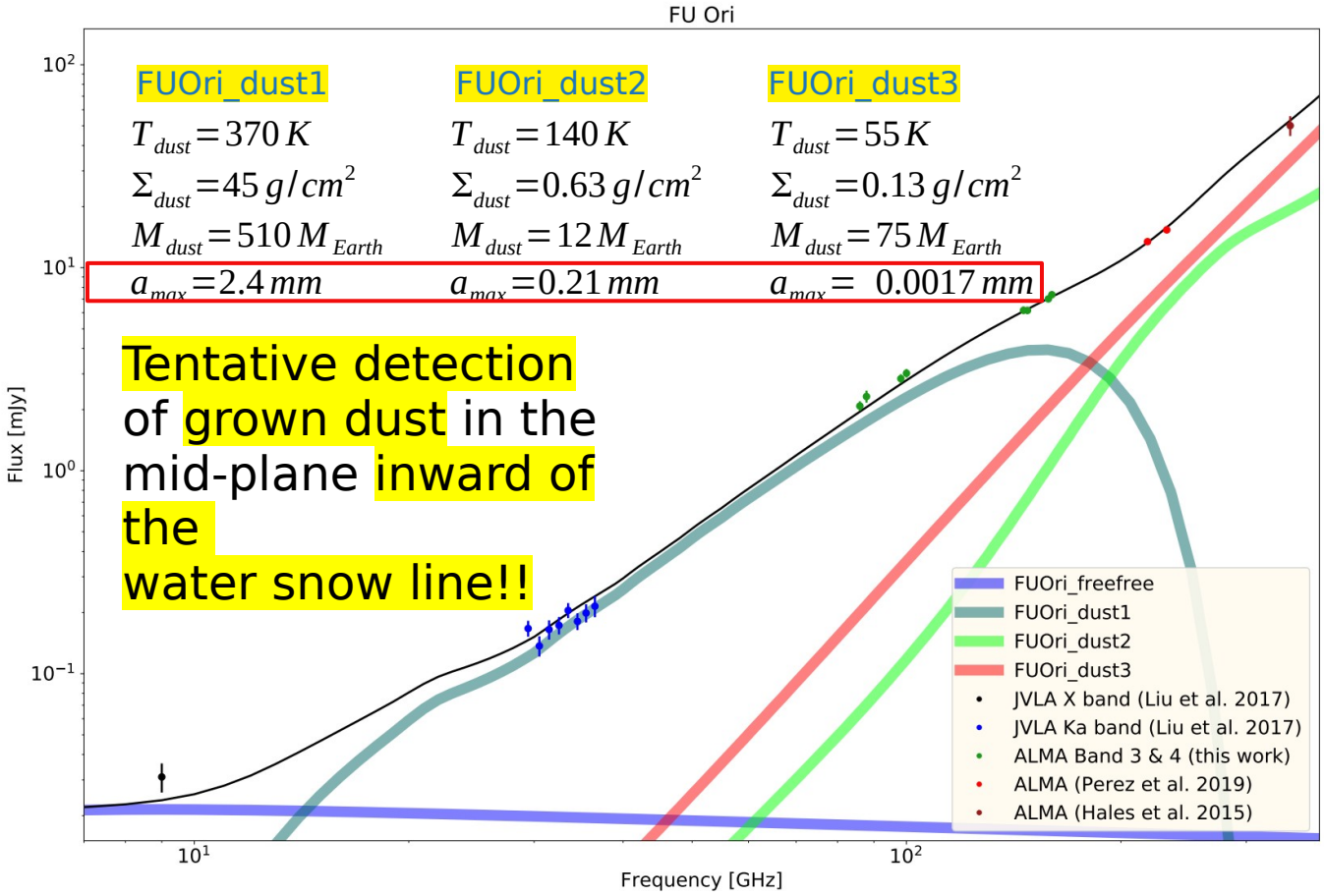

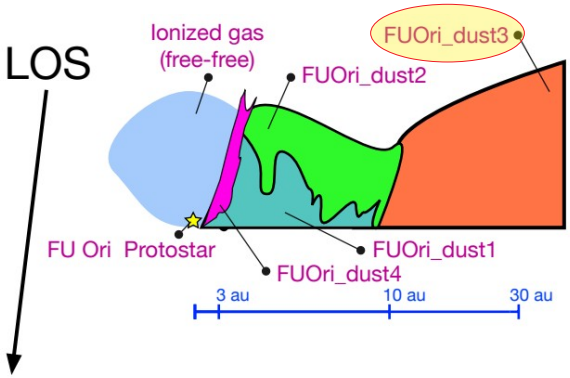

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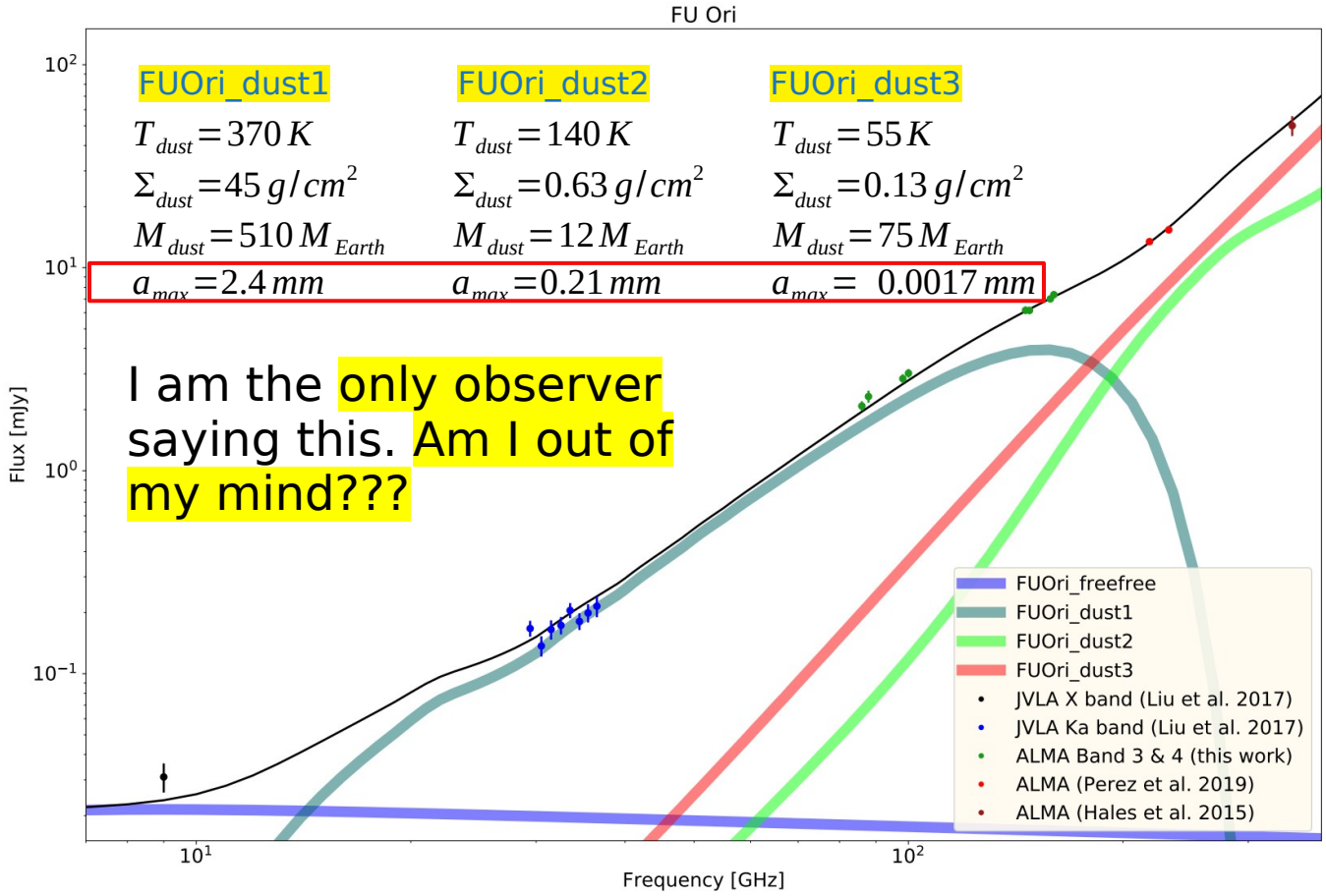
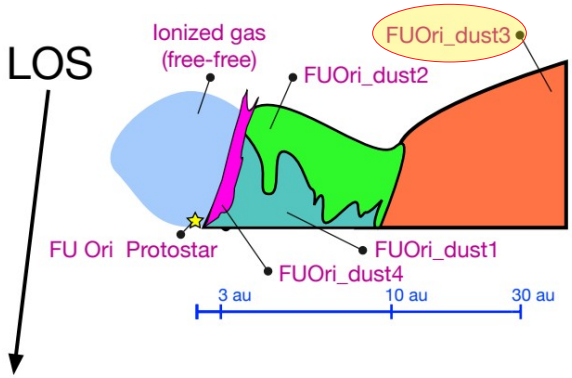
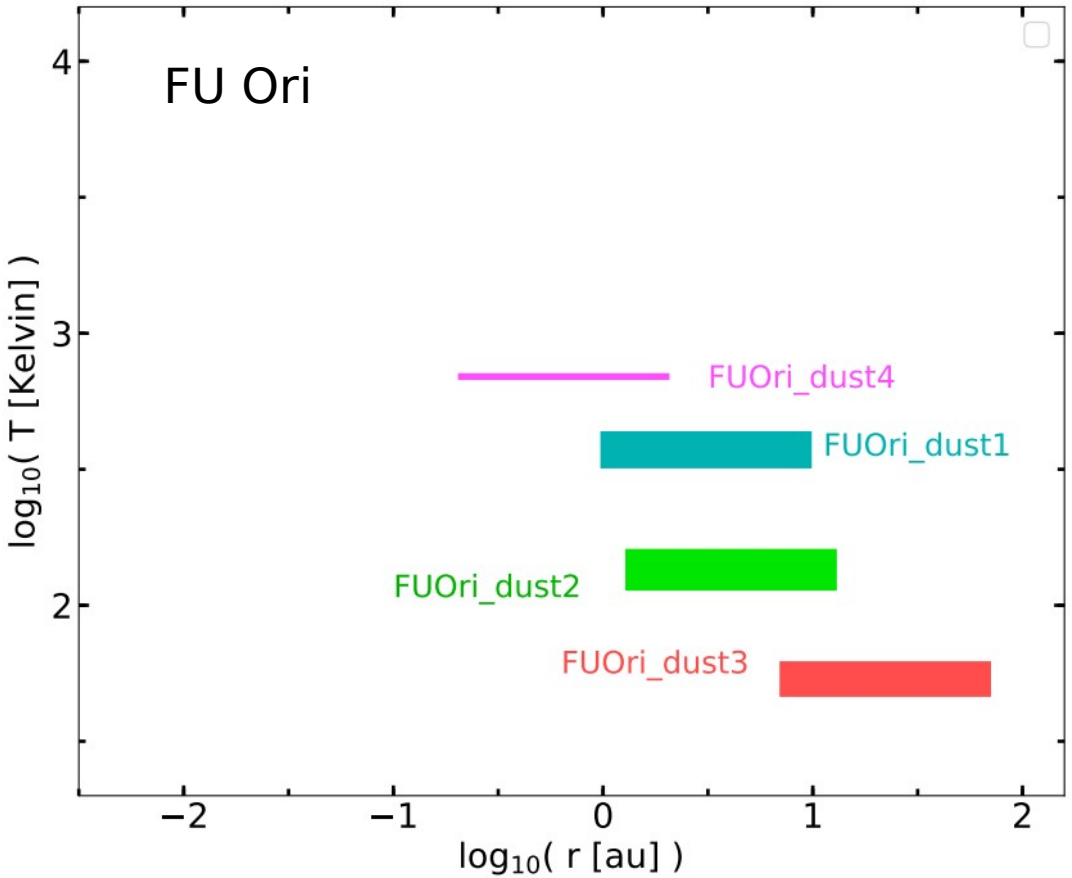
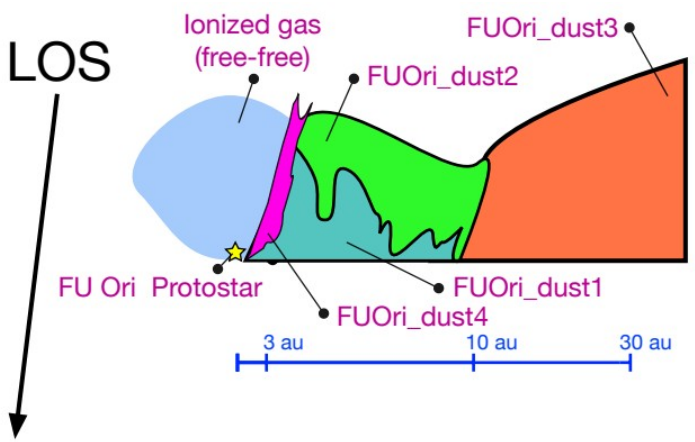


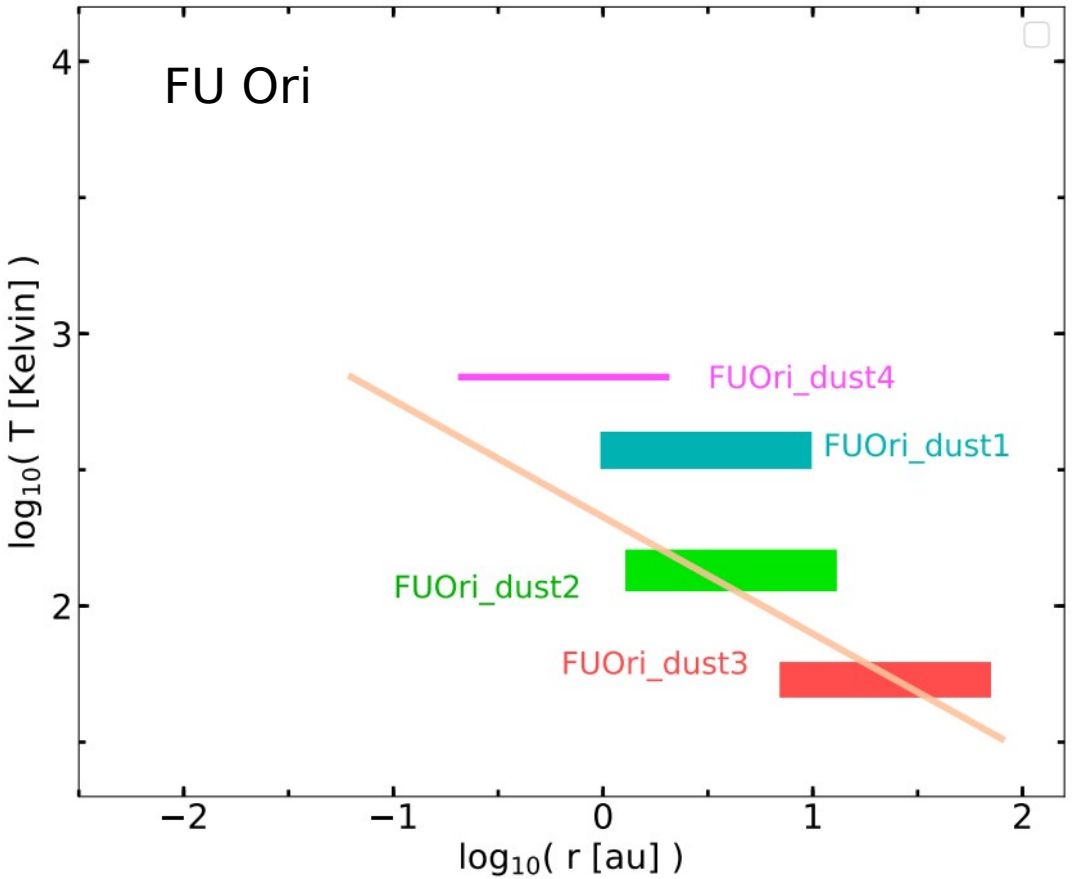


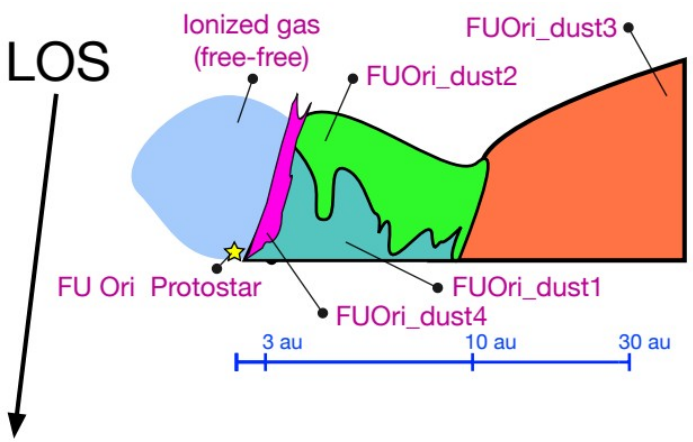
Is our fitted dust temperatures physical?





Radiative heating may not be sufficient, and is hard to explain the vertical thermal profile





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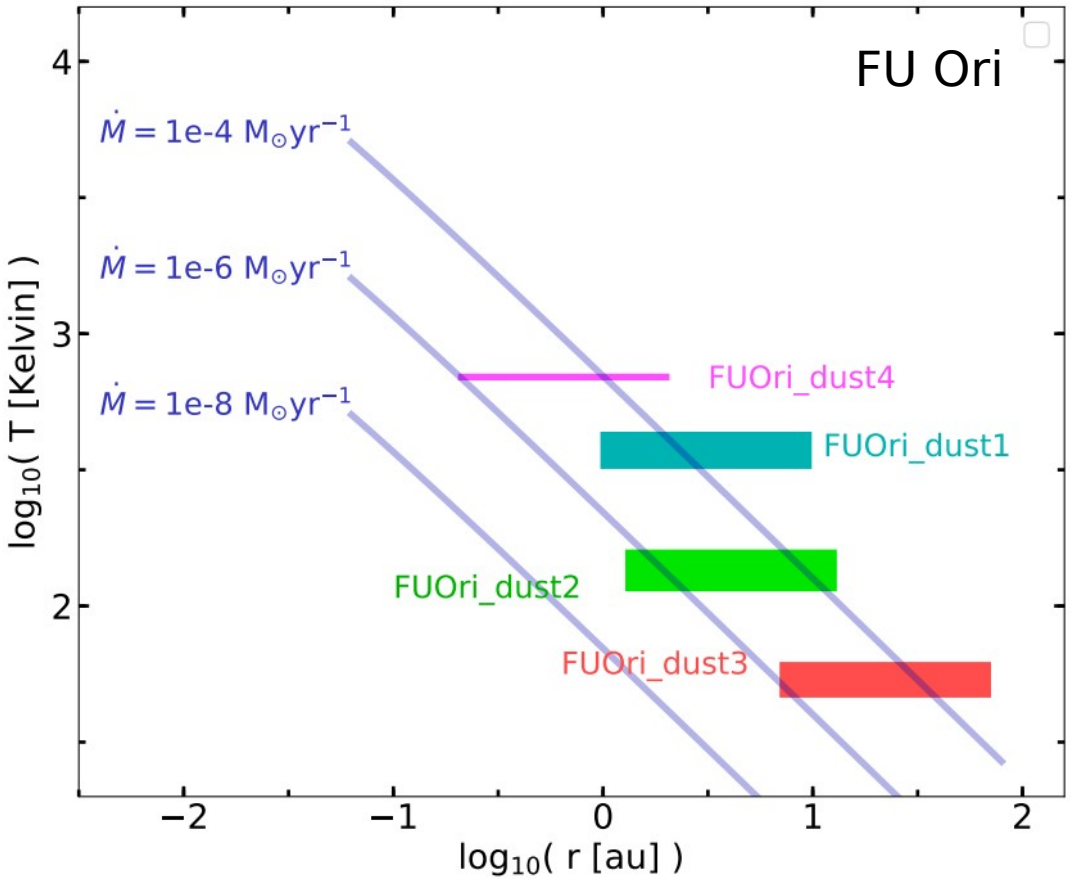

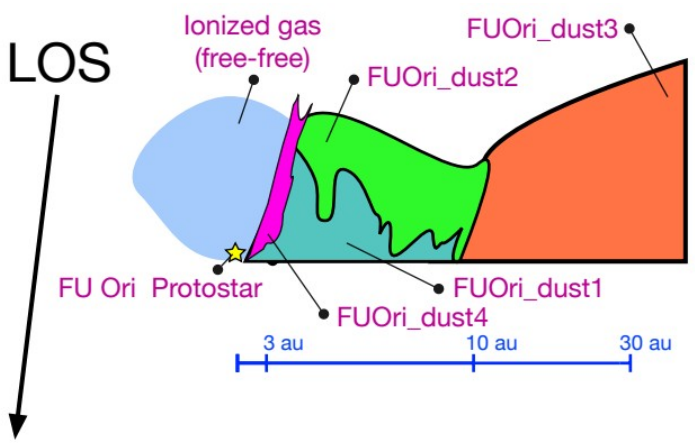

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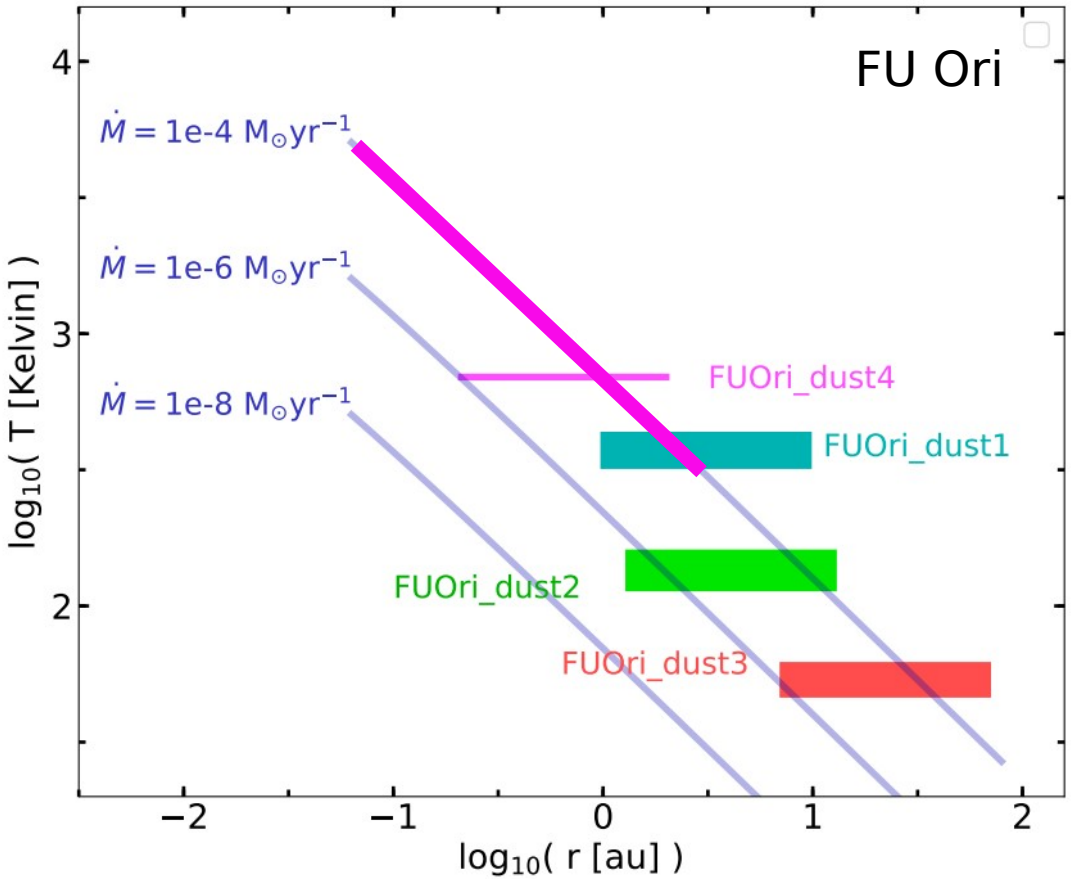

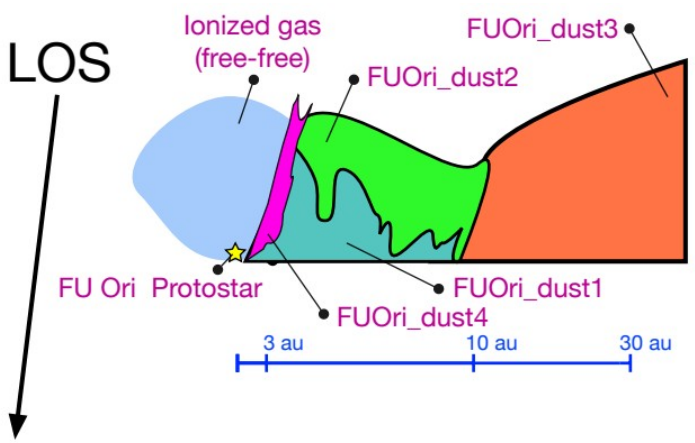

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(Partially verified by the CHARA optical interferometry; Labdon et al. 2020)

Conclusion

1. The inner few au disk can hide considerable dust (and gas masses). In the case of FU Ori it is **500 M_{Earth}** of dust mass and likely **>170 $M_{Jupiter}$** of gas mass. There was **20 $M_{Jupiter}$** of gas+dust accreted onto the host protostar over the **last century**, which is **~10%** of the overall disk mass we detected.

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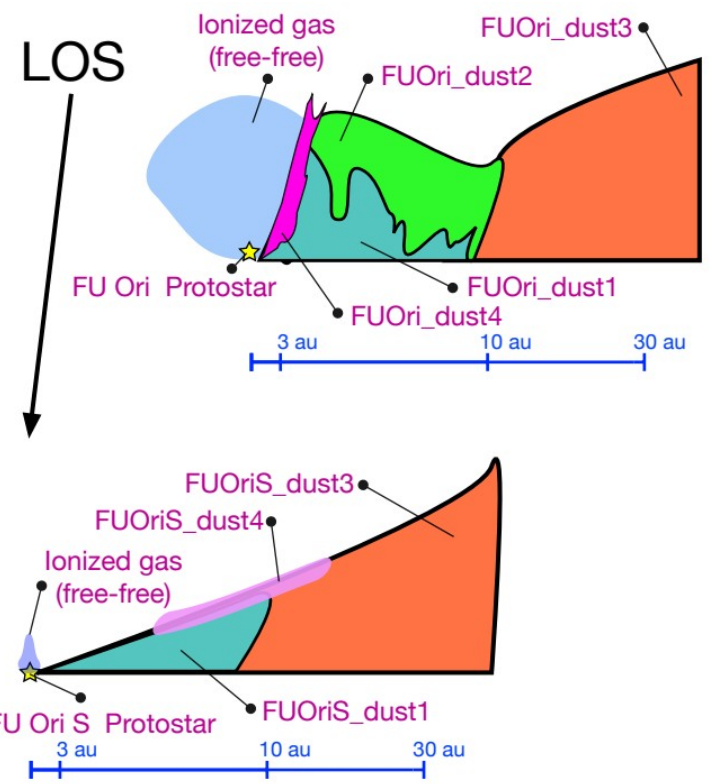
3. Millimeter-sized dust might have been detected from FU Ori but not FU Ori S.



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