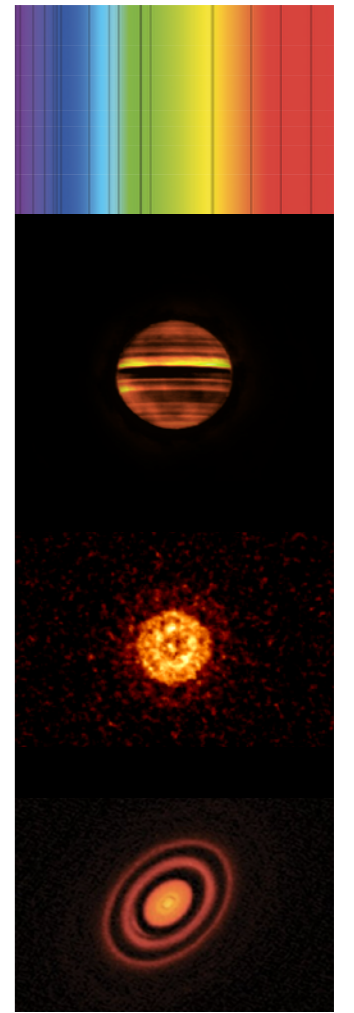
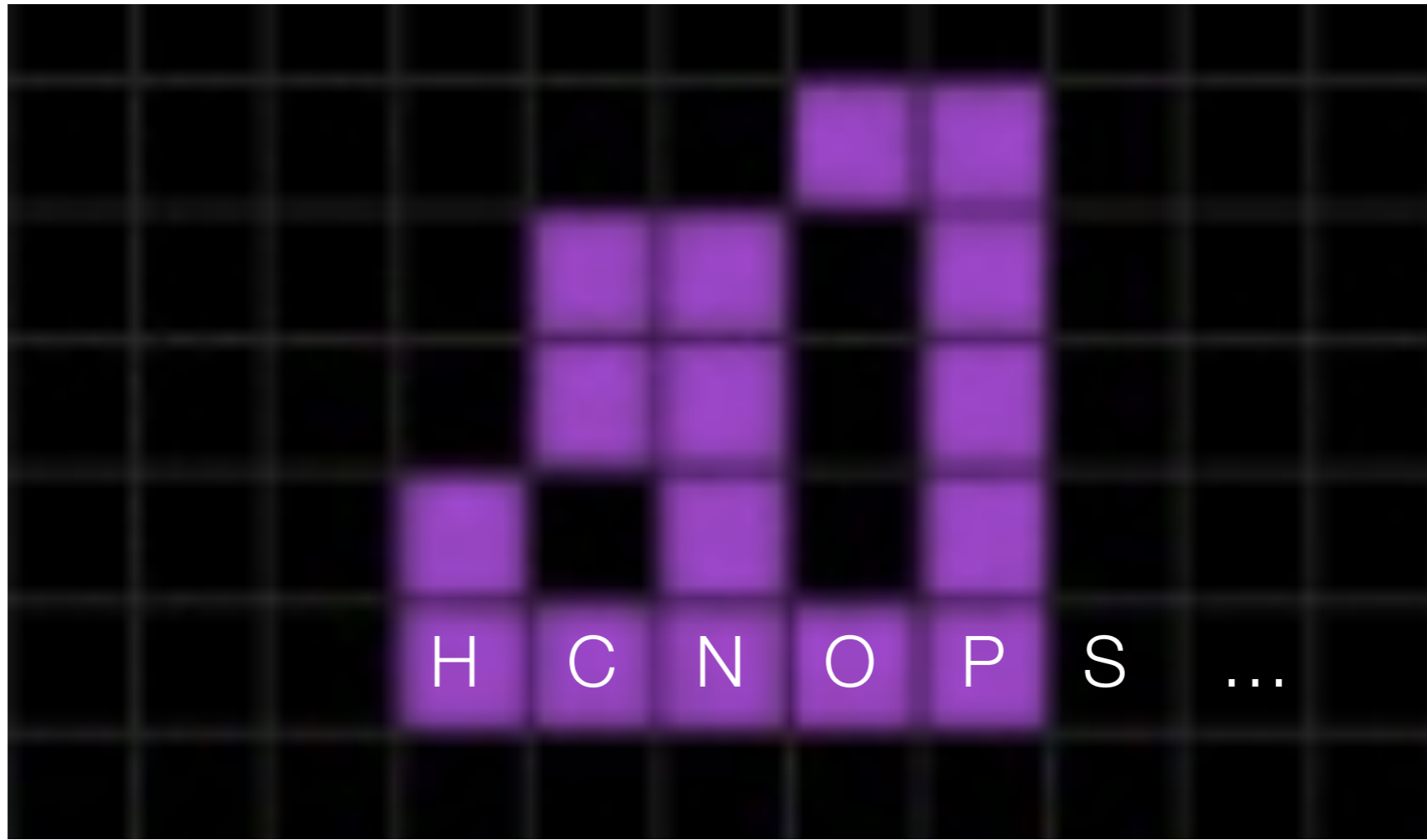
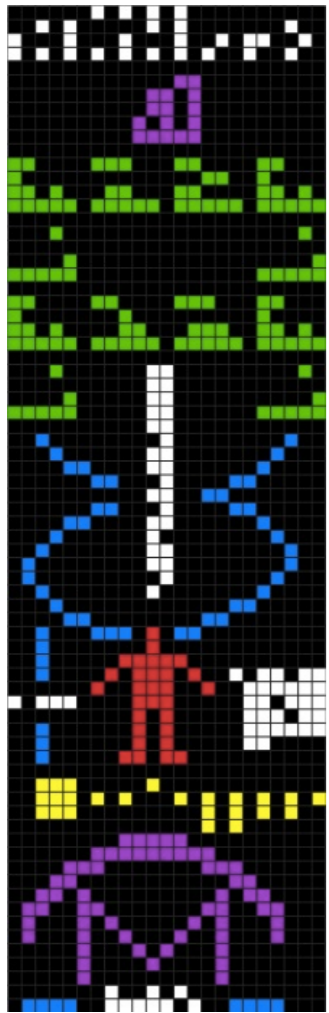


# Linking planets to disks with elemental ratios



*Arecibo message (1974)*

Mihkel Kama

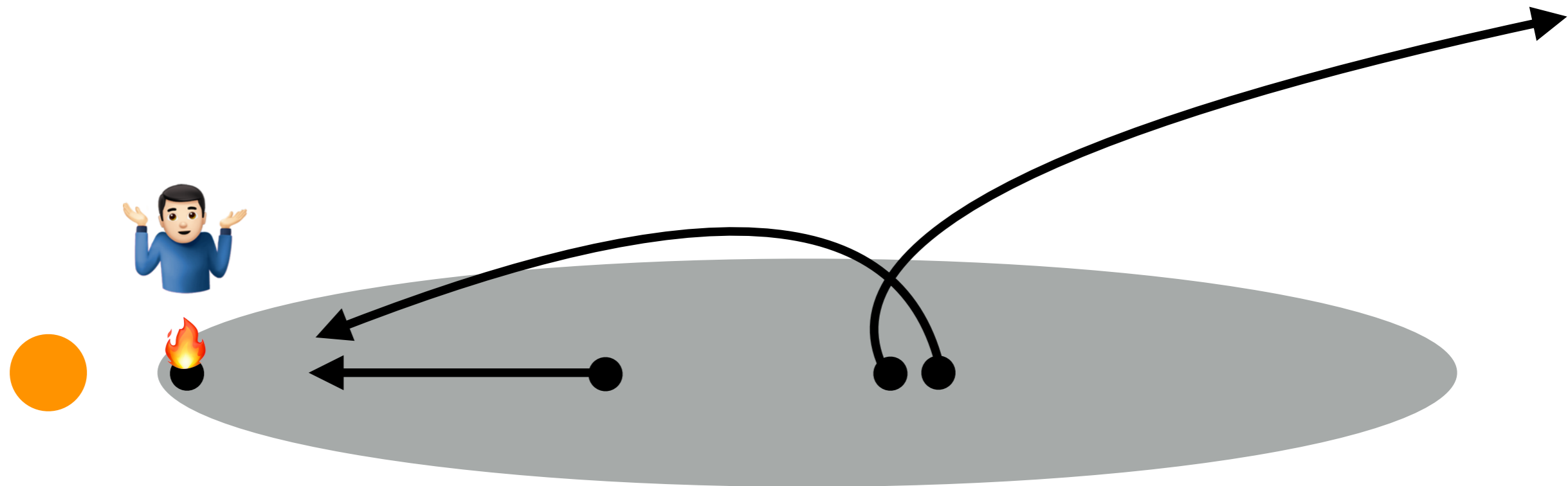
University of Tartu / University of Cambridge

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@kamatahvel



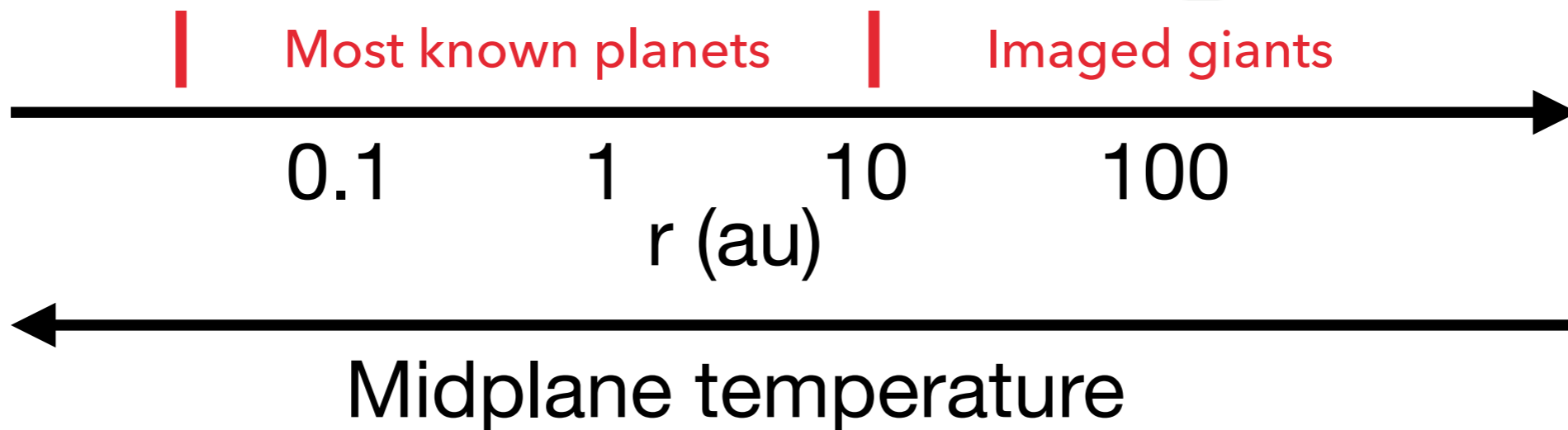
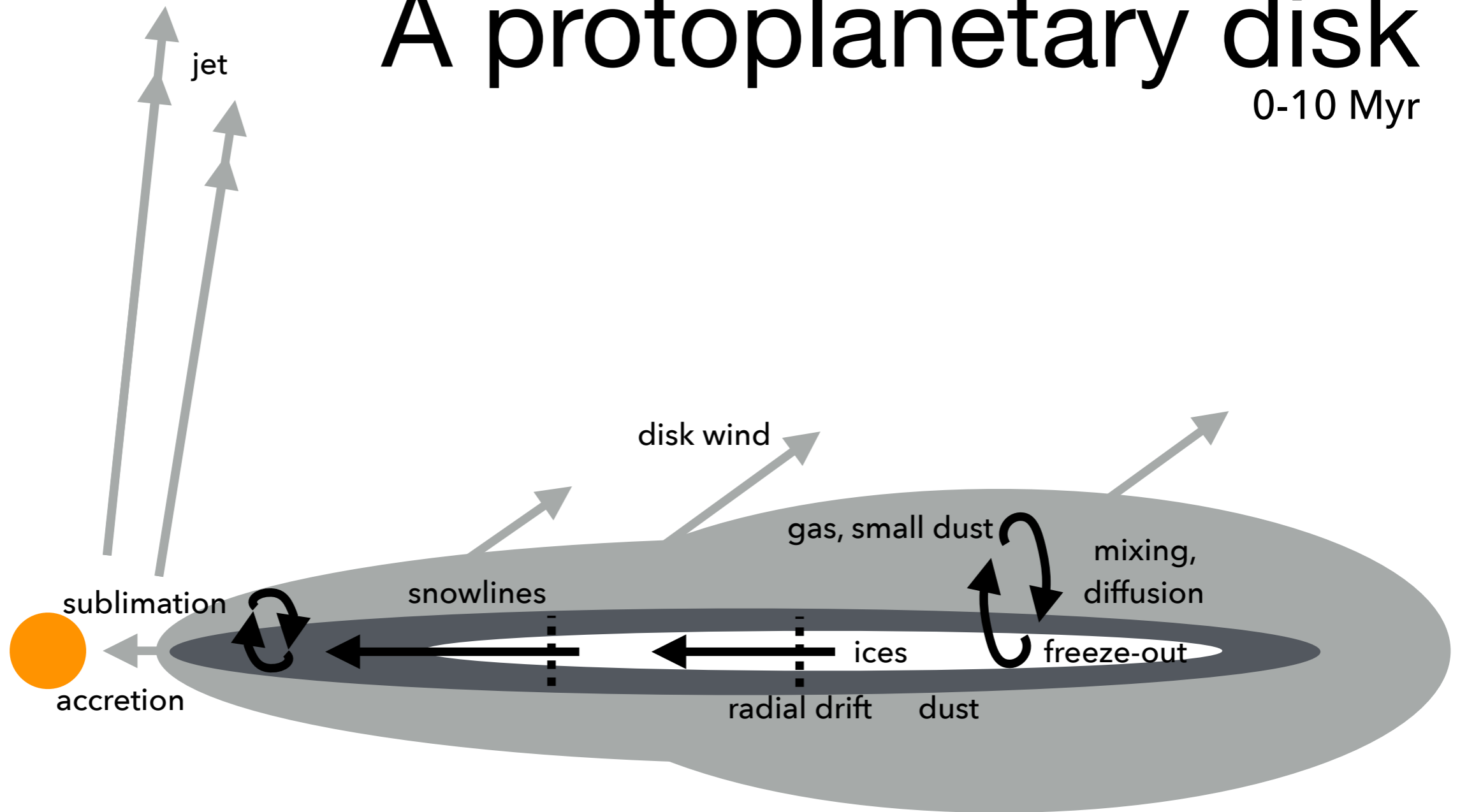
# Planets can move...



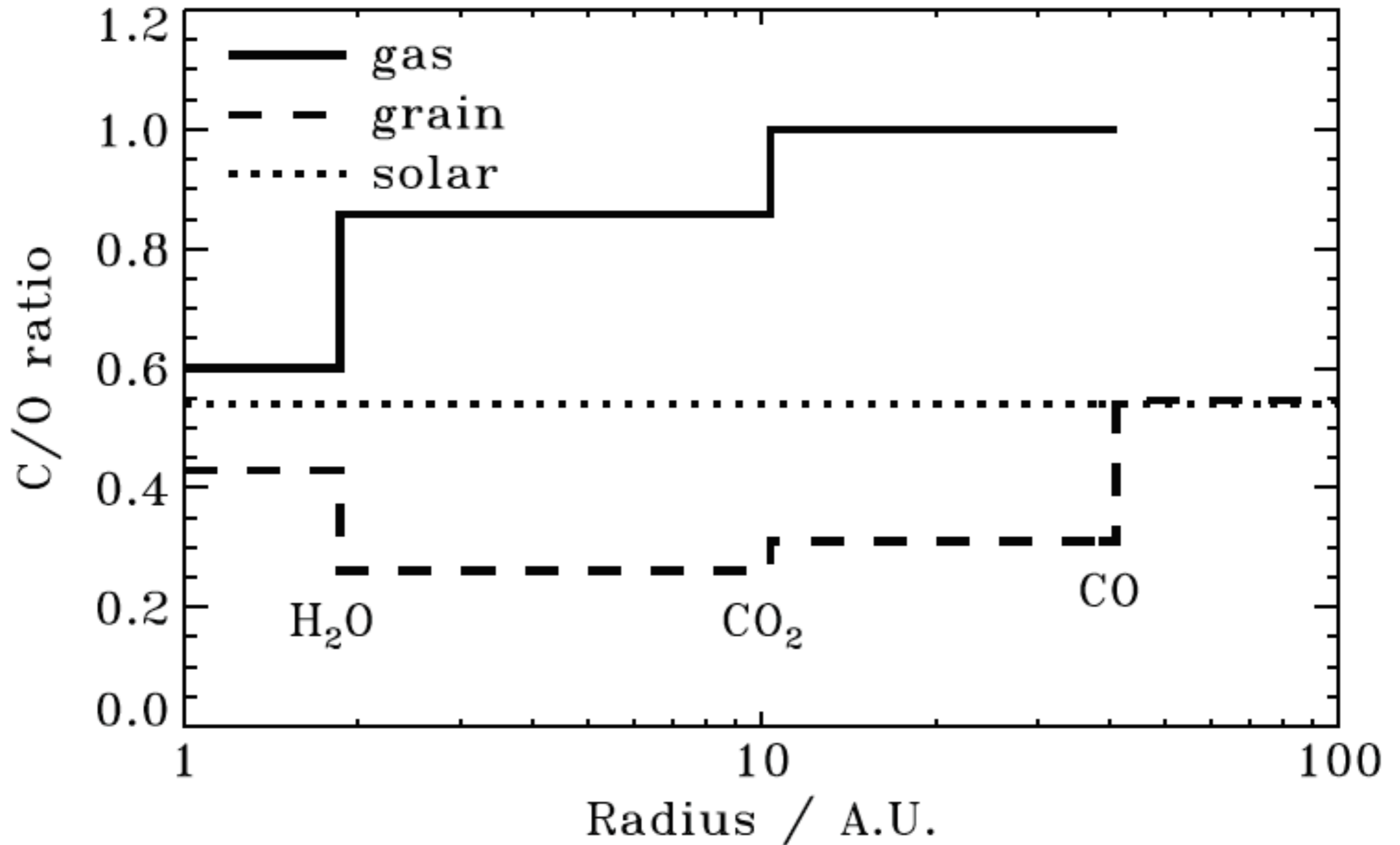
...but can we relate their composition to their origin?

# A protoplanetary disk

0-10 Myr



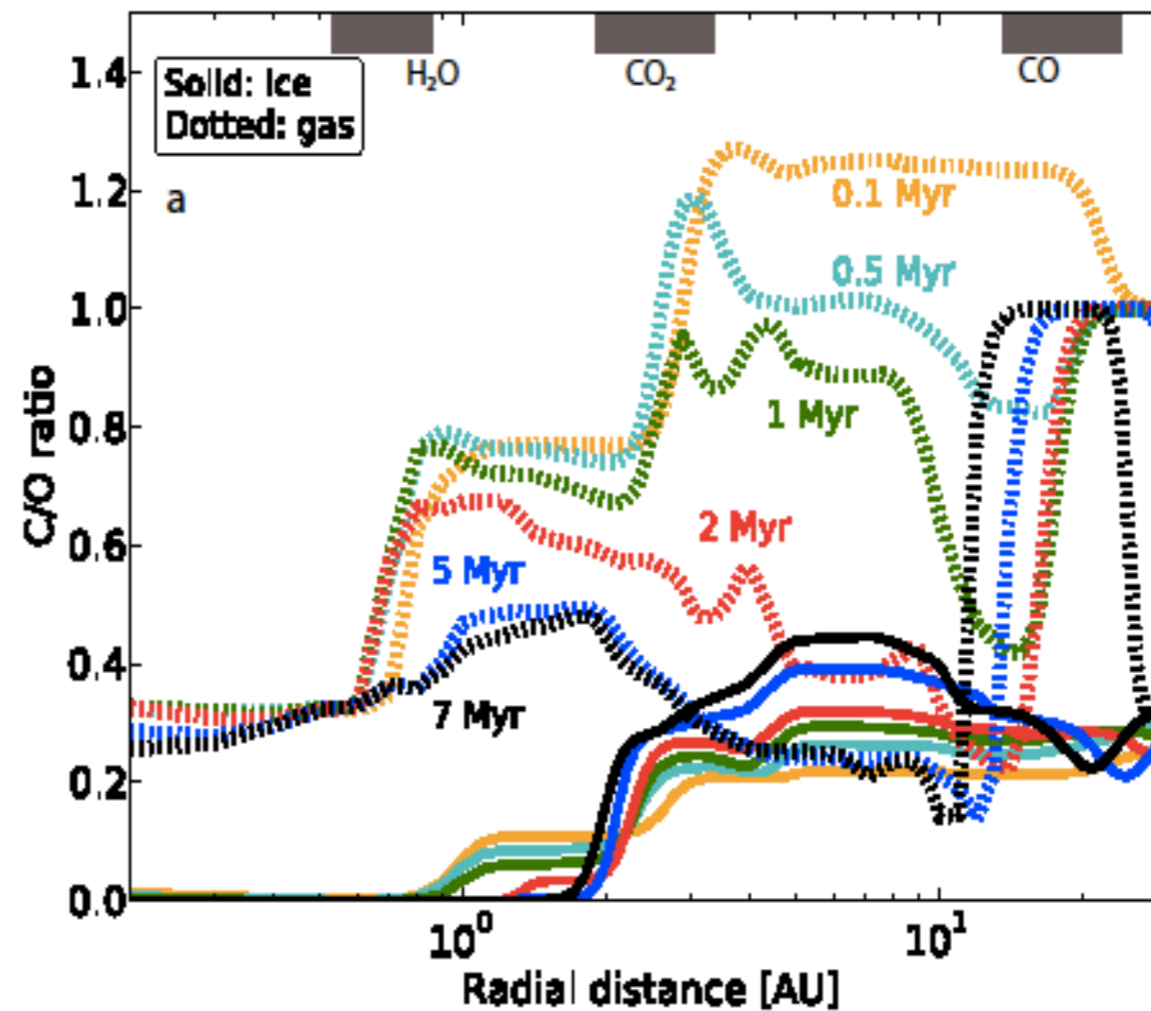
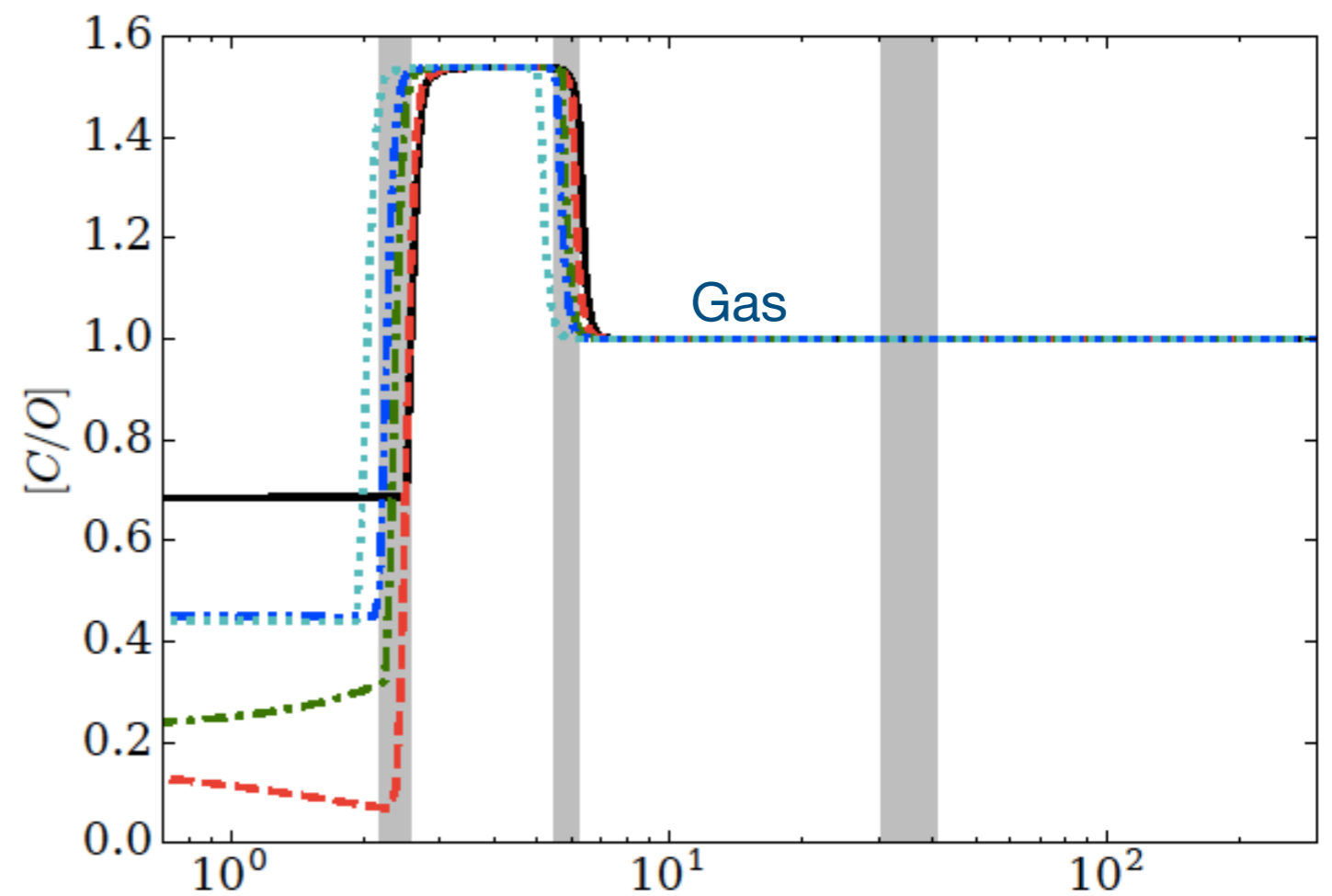
# A planet-disk C/O connection hypothesis



Adding physics,  
chemistry complicates  
the picture

Pebble drift

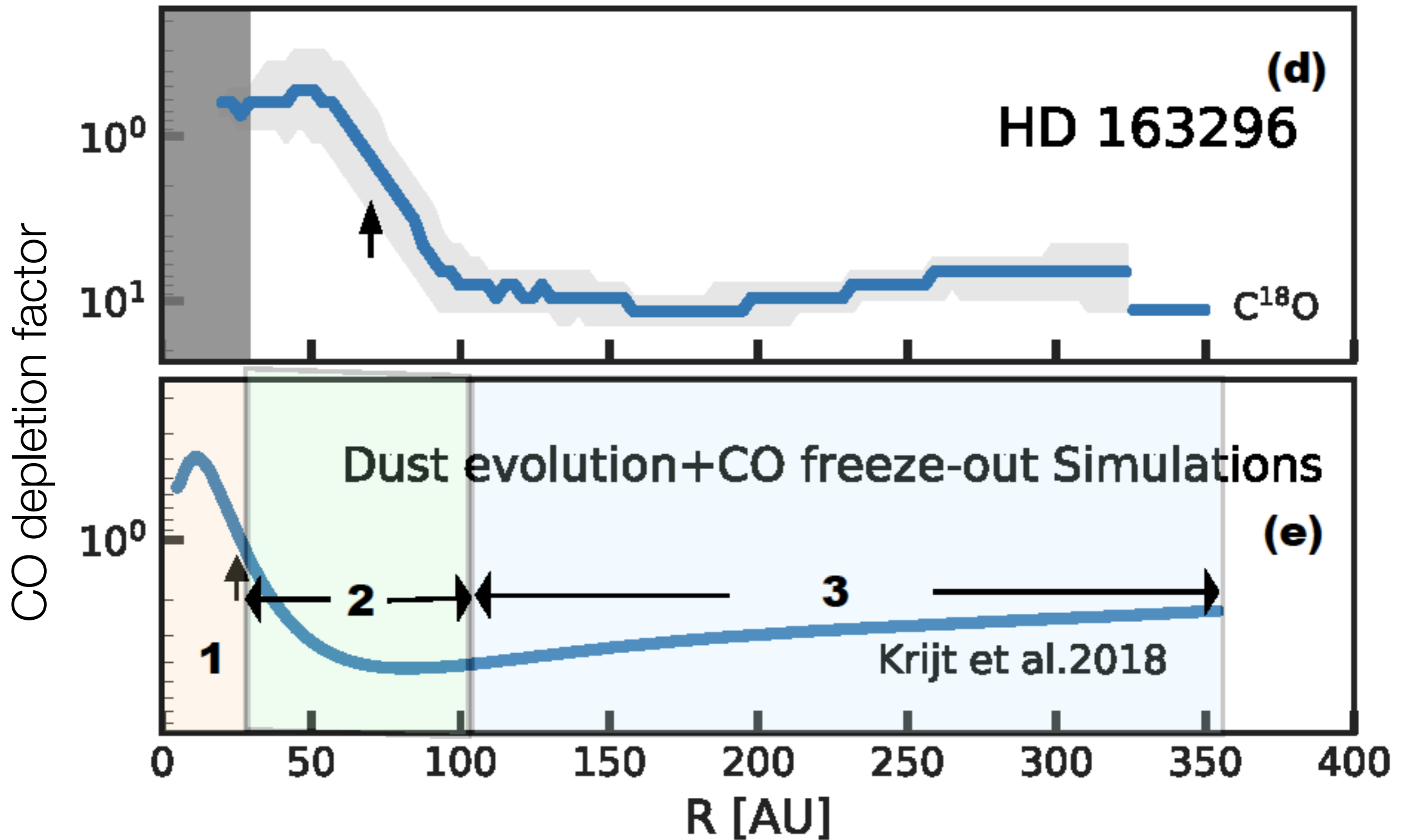
Chemistry &  
evolving disk



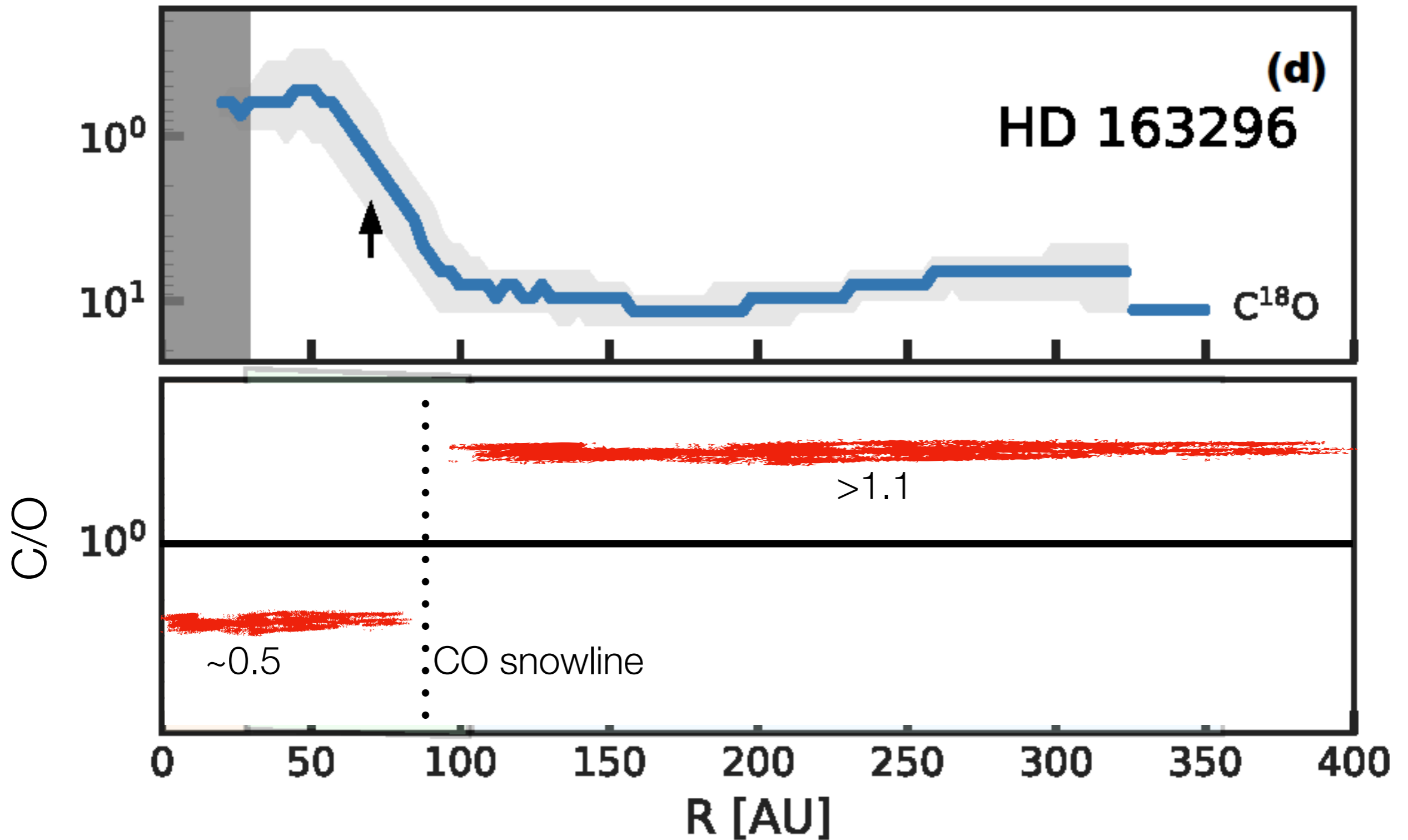
# Measured gas-phase ratios in disks

| Object    | C/H<br>( $\times 10^{-4}$ ) | C/O   | N/O   | S/H<br>( $\times 10^{-5}$ ) |
|-----------|-----------------------------|-------|-------|-----------------------------|
| Sun       | 2.69                        | 0.55  | 0.16  | 1.32                        |
| DM Tau    | 0.2 ... 1.0                 | > 1   |       | < $10^{-2}$                 |
| GM Aur    | $10^{-2}$                   |       |       |                             |
| GO Tau    |                             | > 1   |       | < $10^{-2}$                 |
| HD 100546 | 1.35                        | < 0.9 |       | $\sim 10^{-4}$              |
|           | 0.135                       | < 0.9 |       |                             |
| IM Lup    |                             | 0.8   | 10    |                             |
| LkCa 15   |                             | > 1   |       | < $10^{-2}$                 |
| TW Hya    | 0.01                        | > 1.1 |       | $\sim 10^{-4}$              |
| Jupiter   | 2.37                        | <0.48 | <1.36 | 8.9                         |

# Spatially resolved CO abundance



# Spatially resolved CO abundance

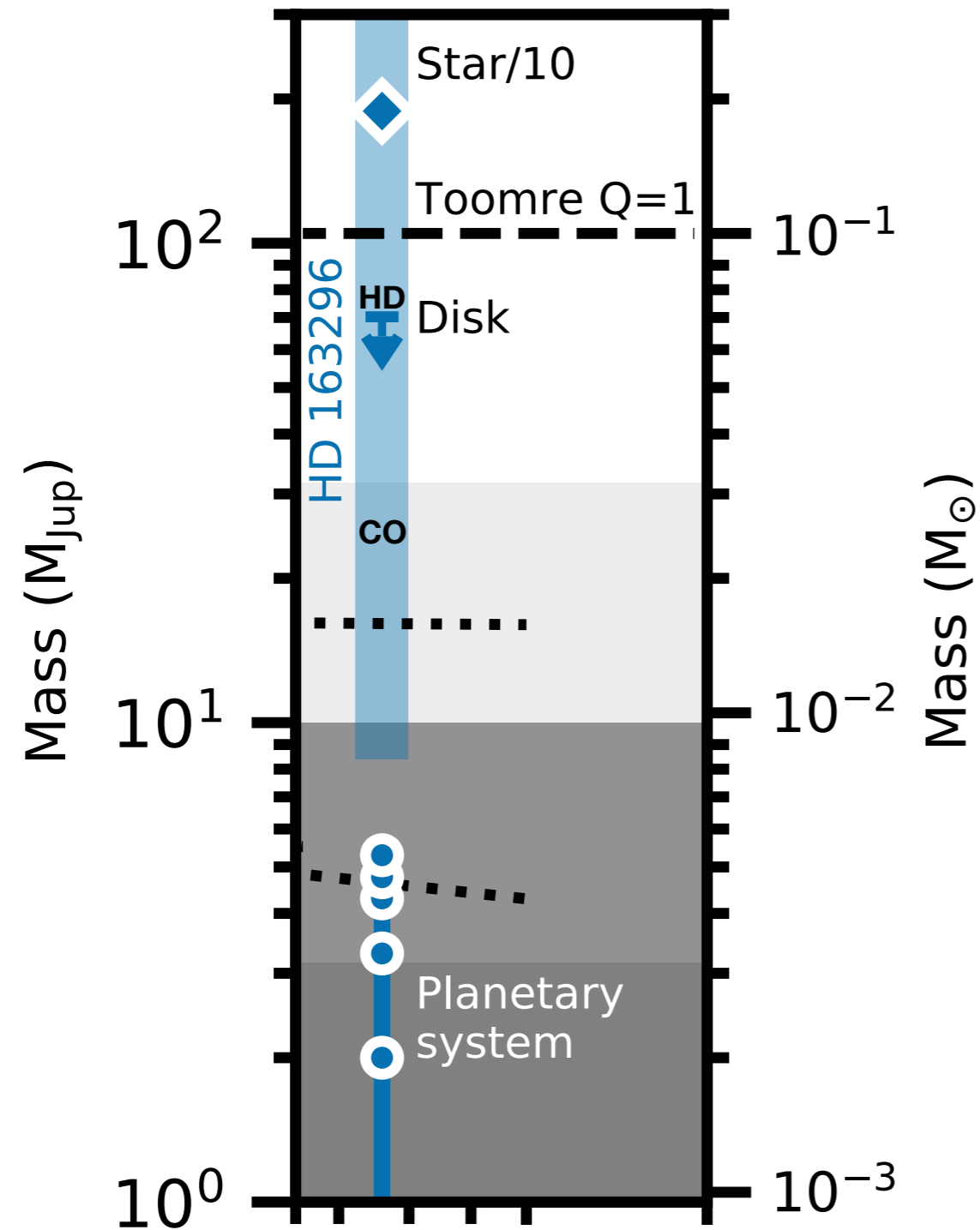


work in progress

see also Kama et al. (2015, inner disk); Bergner et al. (2019, outer disk)

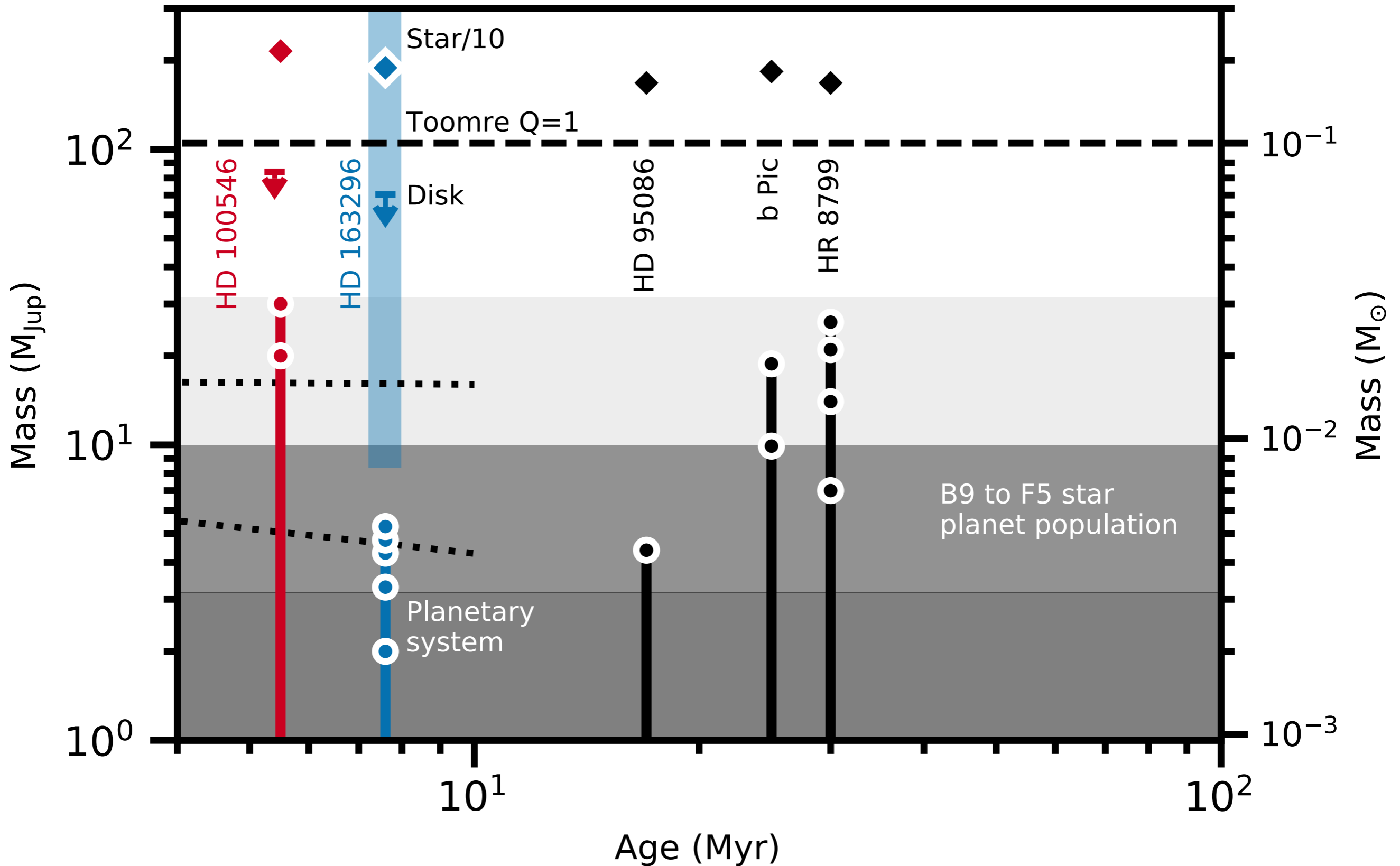


# A-type stars: where we link planets to disks

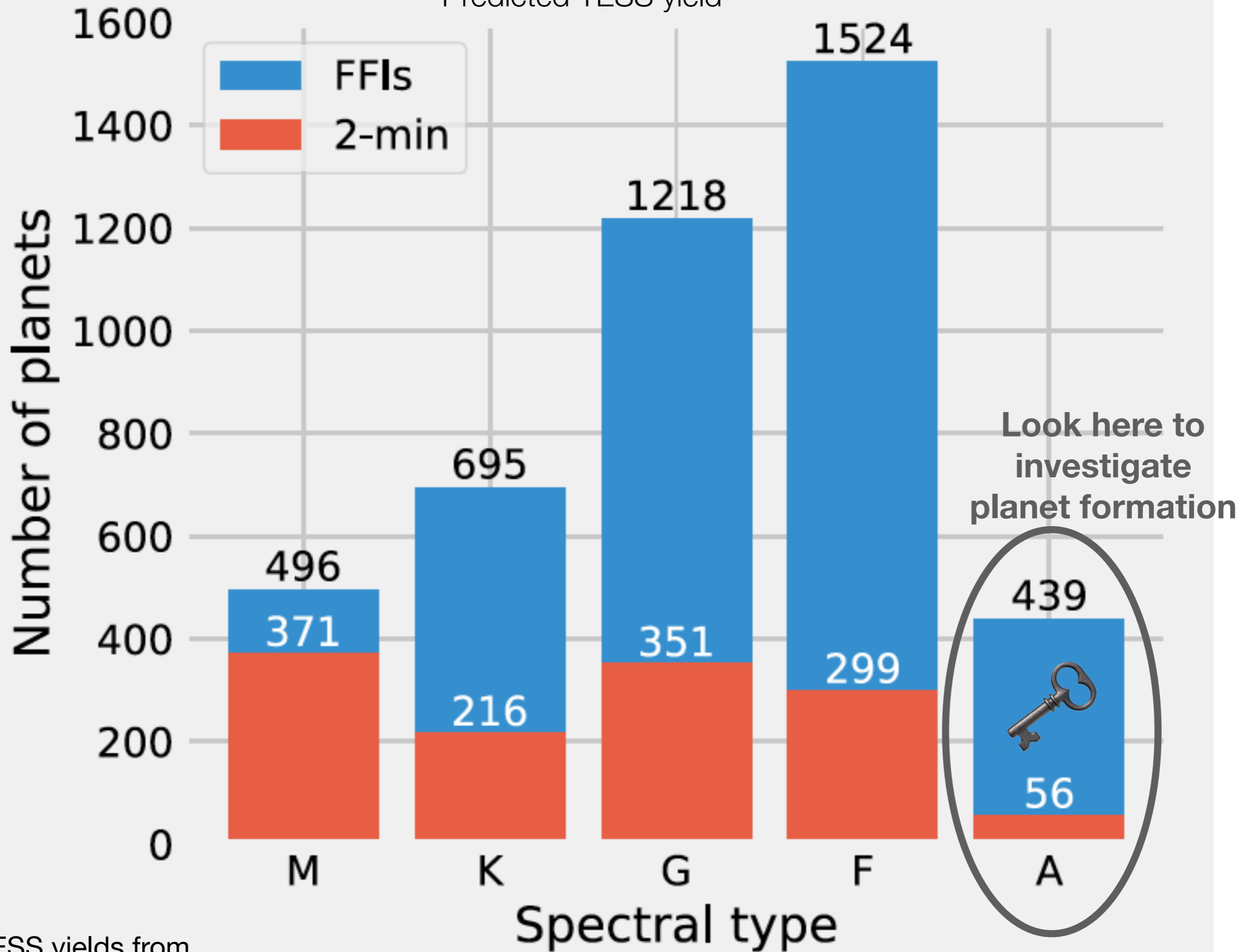


HD 163296

# A-type stars: where we link planets to disks



Predicted TESS yield



Look here to investigate planet formation



# Unlocking the science:

## Outlook on disks leading up to ARIEL

- Characterisation of CHNOPS reservoirs in disks  
*see Kama et al. (2019, ApJ) for S*
- Spatially resolved elemental ratio measurements + models  
*work in progress*
- Planets, disks of A-stars can constrain formation, migration:  
include A-type star HJs in space missions  
*Kama et al. (2019, arXiv) and in prep*

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