Effects of Metallicity on TiC, SiC, and Graphite Condensation

Gabrielle Adams and Katharina Lodders
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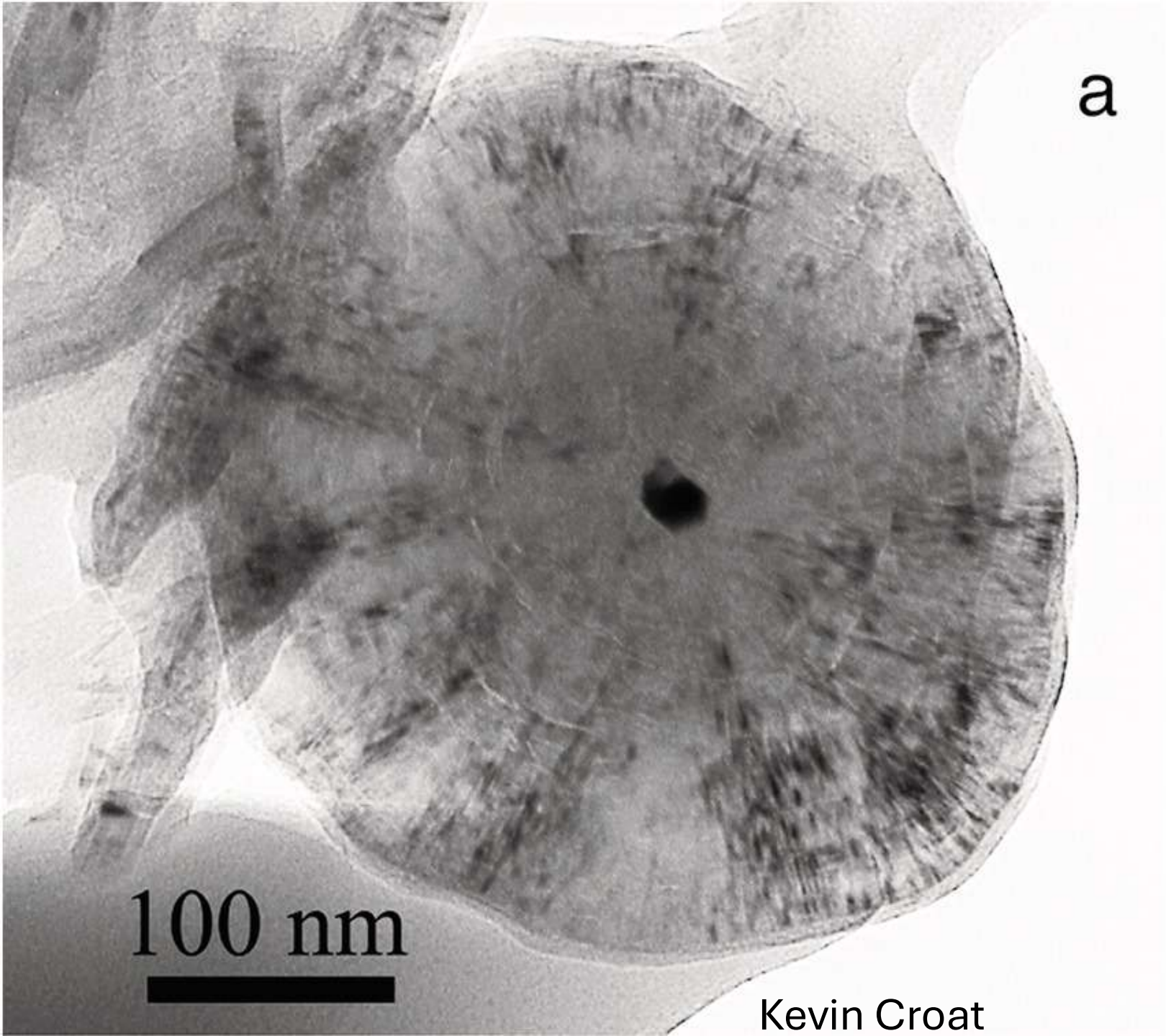
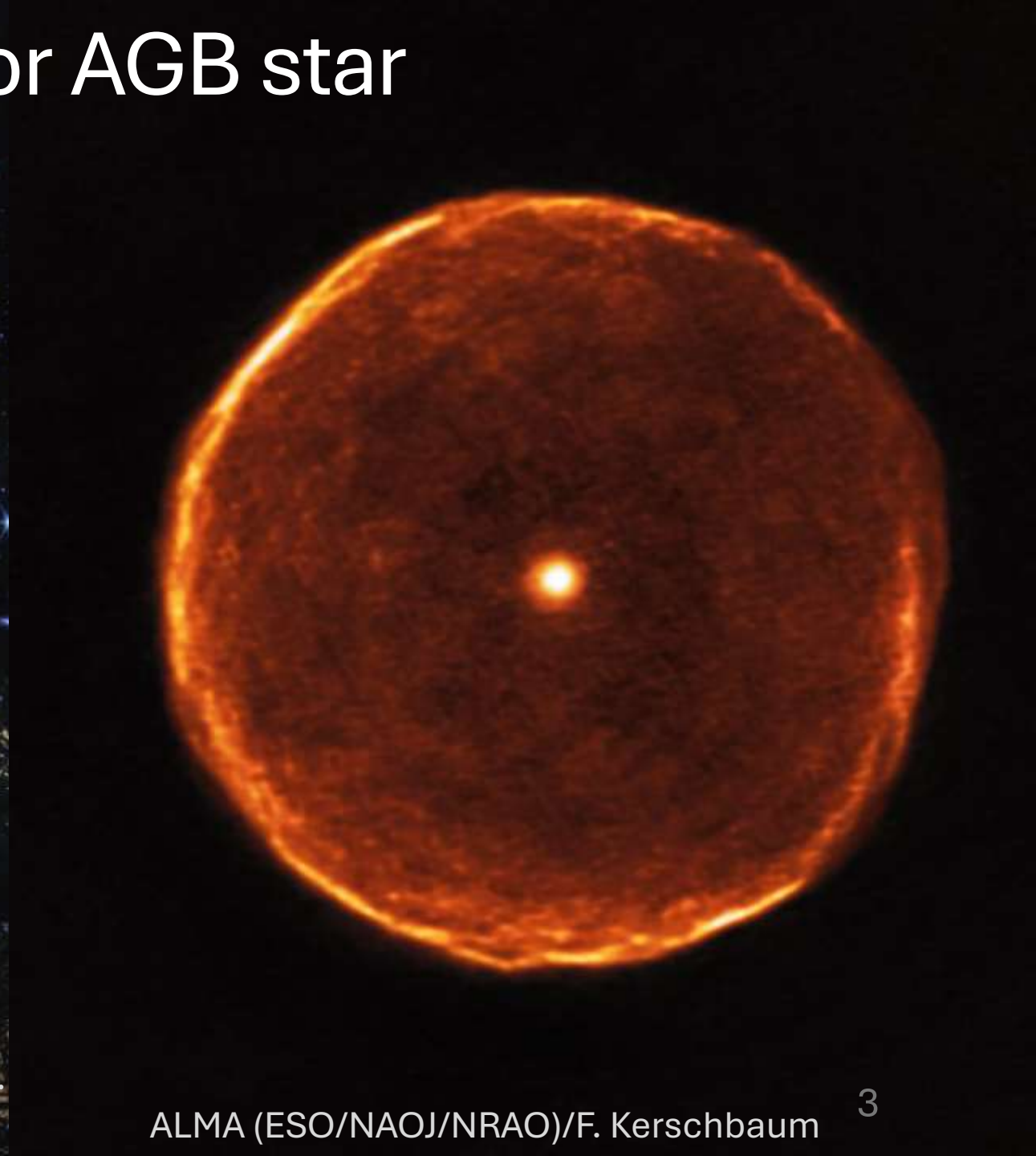


Kevin Croat

- Ancient dust preserved in primitive meteorites
- Present in solar nebula
- A (biased) sample of presolar material

Supernova or AGB star

NASA, ESA, CSA, STScI, D. Milisavljevic (Purdue University), T. Temim (Princeton University), I. De Looze (University of Gent)



ALMA (ESO/NAOJ/NRAO)/F. Kerschbaum

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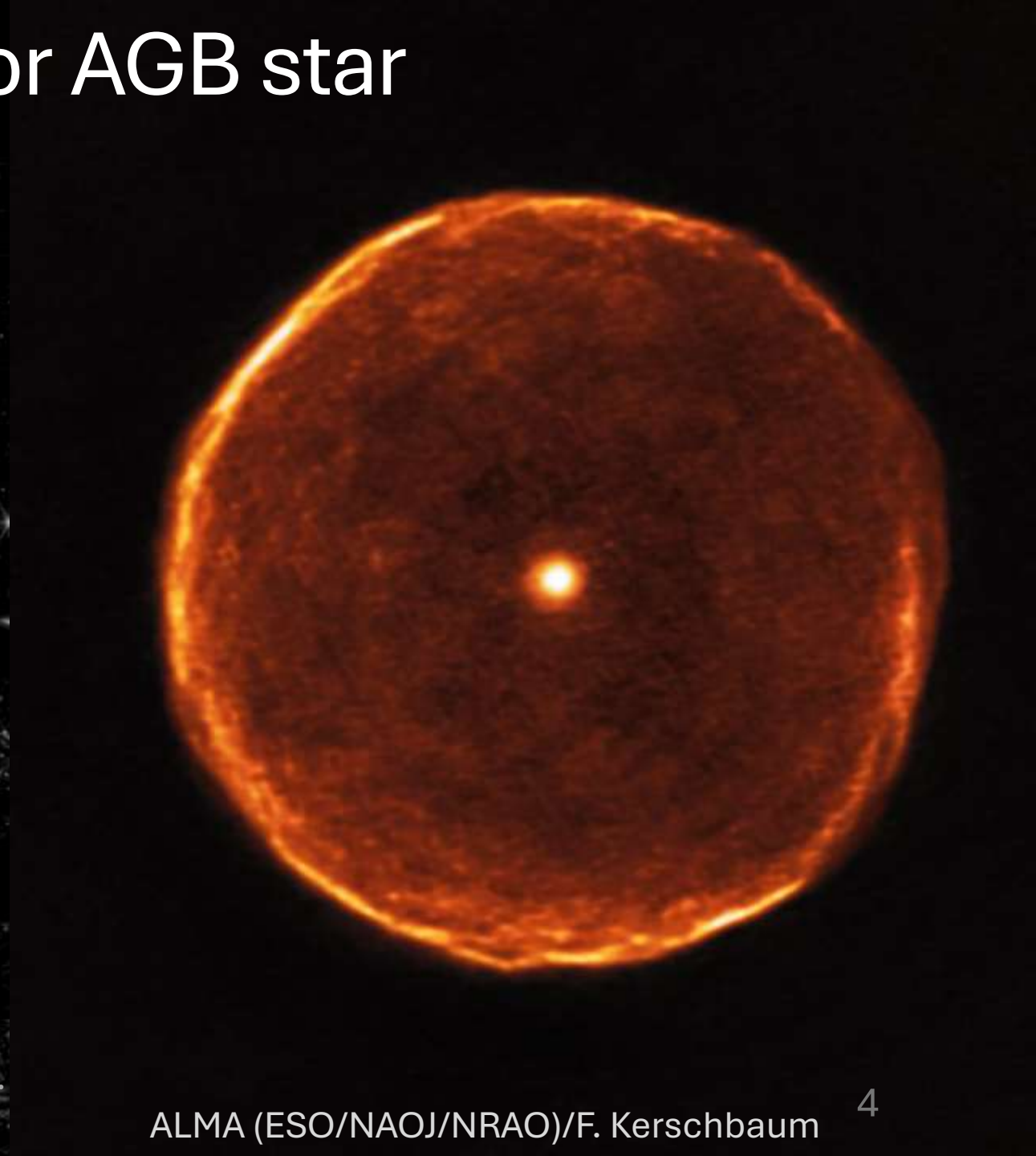


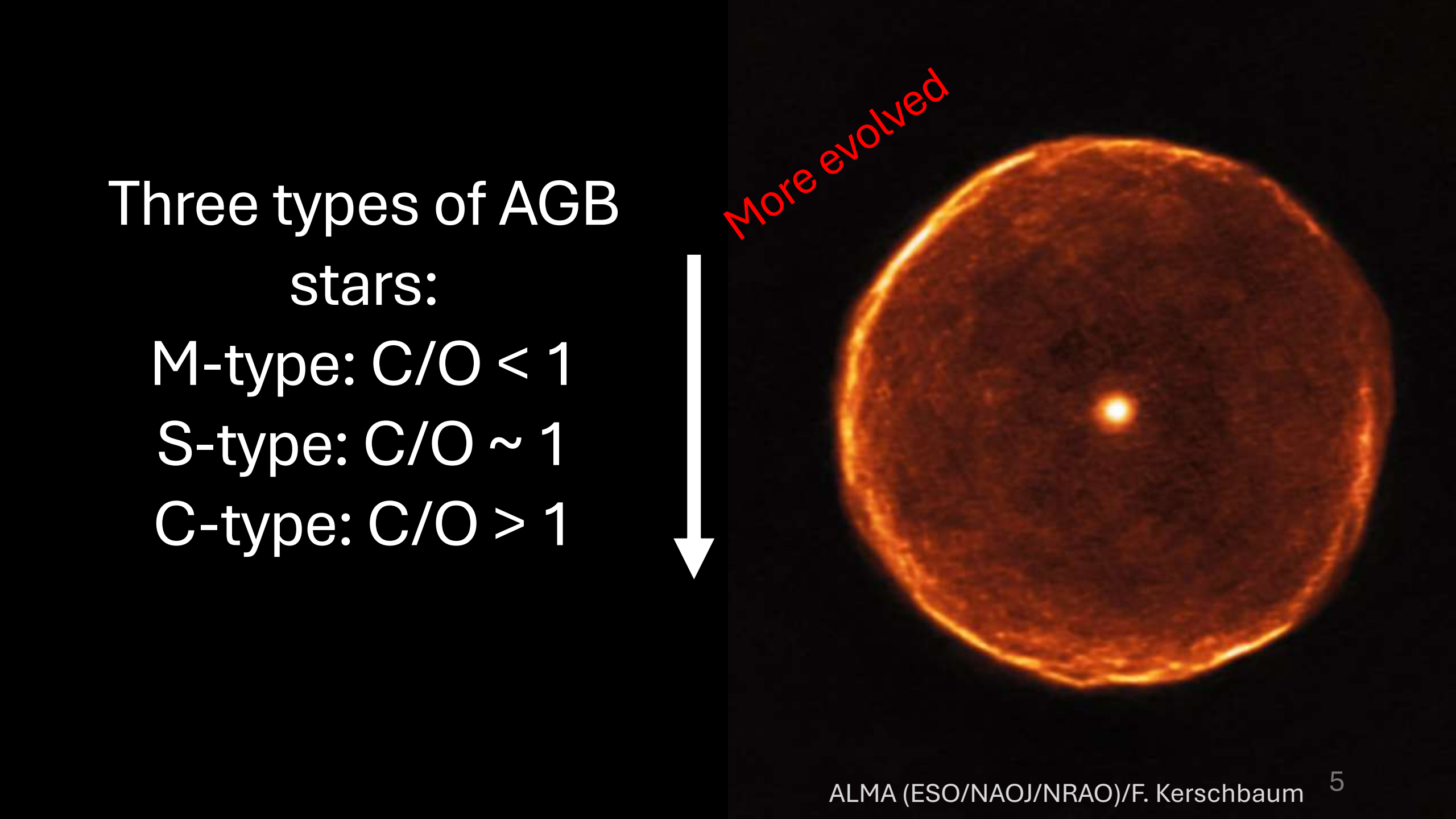
ALMA (ESO/NAOJ/NRAO)/F. Kerschbaum

Three types of AGB stars:

M-type: C/O < 1

S-type: C/O ~ 1

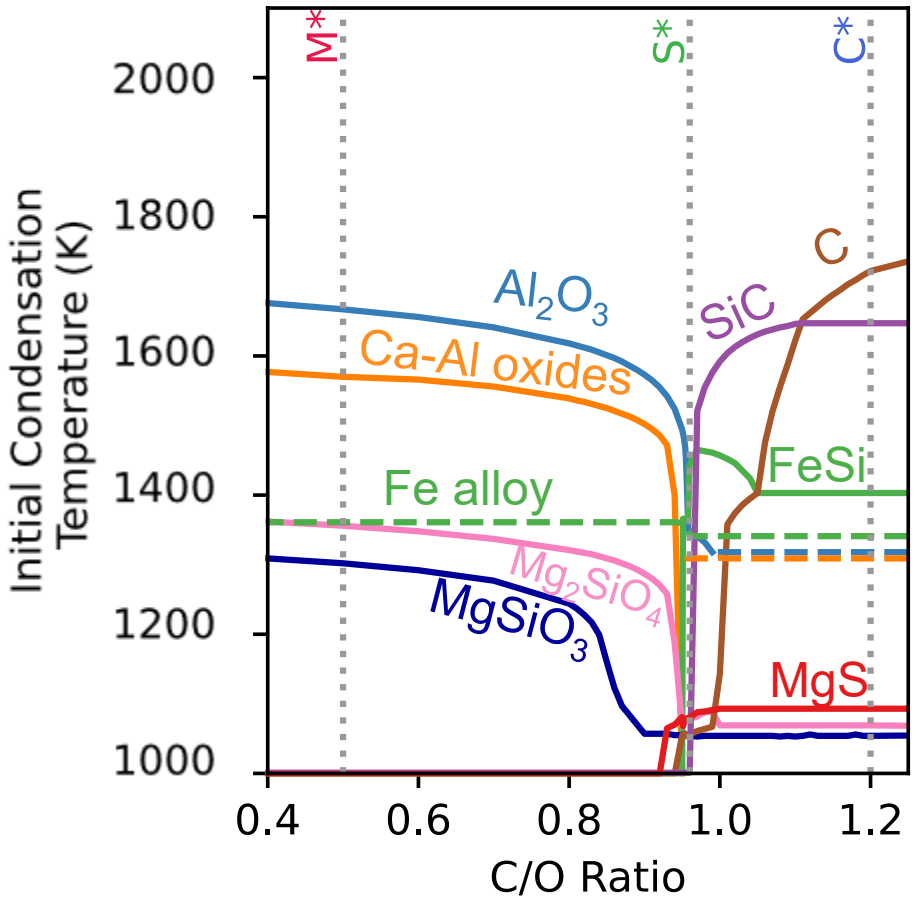
C-type: C/O > 1



ALMA (ESO/NAOJ/NRAO)/F. Kerschbaum

Condensation Computations

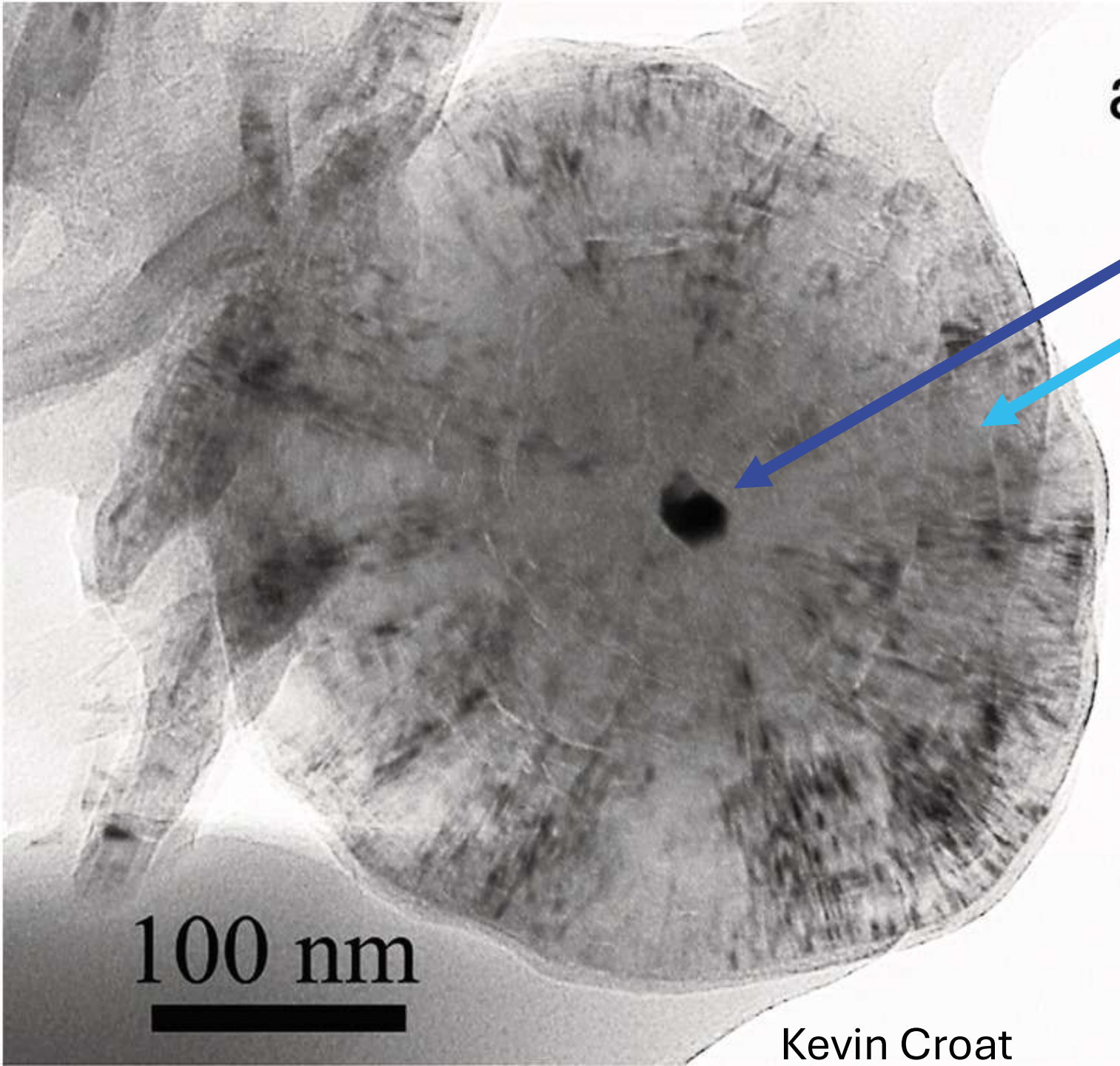
- Useful to interpret and predict grain composition
- Depend on total pressure and bulk composition
- C/O ratio
  - Solar C/O is ~0.56
  - O-rich: silicates and oxides
  - C-rich: carbides and graphite



How to change bulk elemental composition

- C/O ratio

- **Metallicity**
  - Atomic ratio of a heavy element to hydrogen relative to the respective ratio in the Sun
  - Condensation at non-solar metallicity has not been investigated beyond a few exploratory calculations



Graphite grain with central refractory carbide crystal

Kevin Croat

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Effects of Metallicity on Graphite, TiC, and SiC Condensation in Carbon Stars

Gabrielle M. Adams and Katharina Lodders

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DOI 10.3847/1538-4357/adc40f

Method

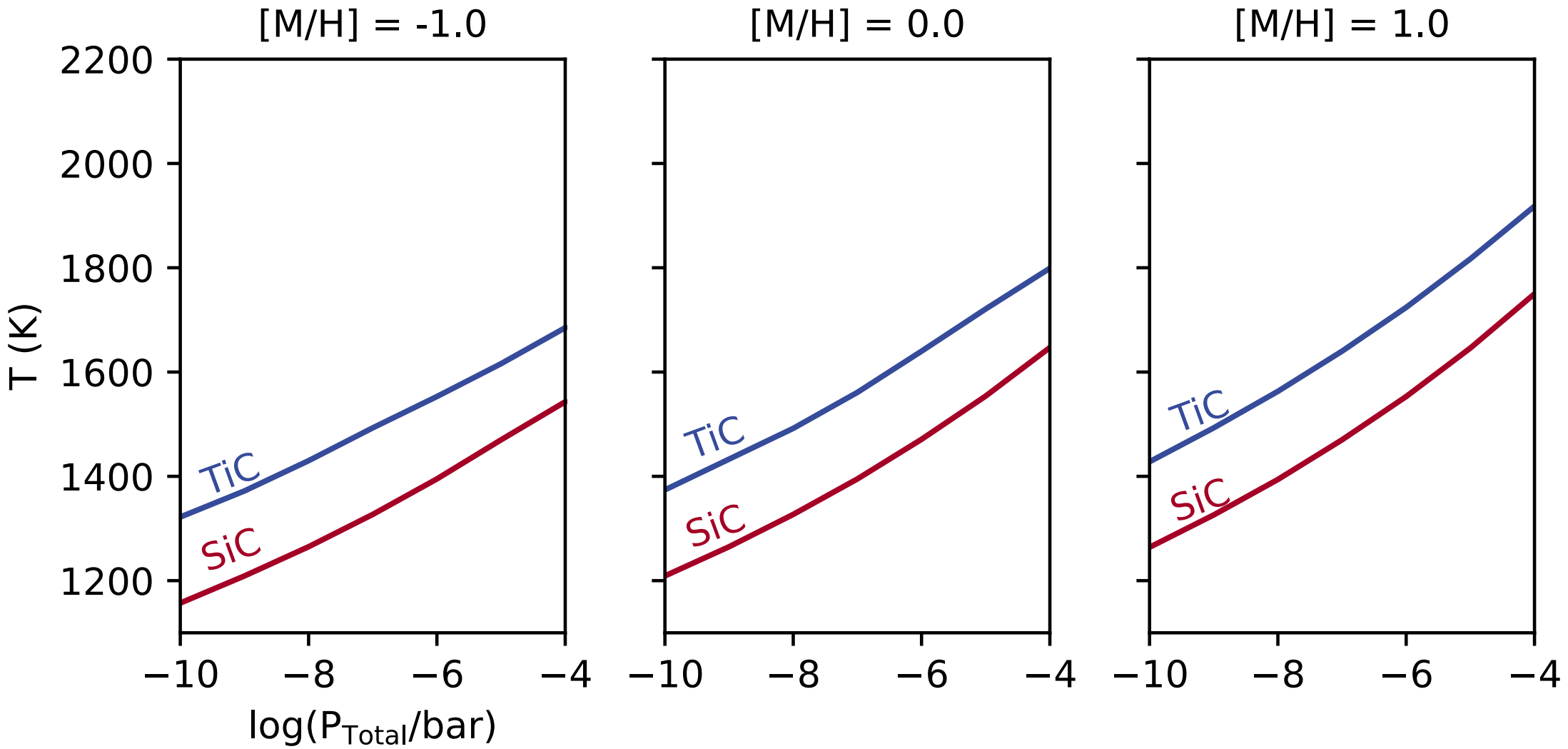
- Thermodynamic equilibrium calculations
- Reducing conditions: C/O = 1.2 (Lambert et al. 1986)
- Uniform metallicity factor for all elements heavier than He
- Ranging from 0.01 to 100 times solar metallicity, [-2] to [2]
- C/O = 1.1 and 3.0 also investigated

Key points

- Increasing metallicity increases condensation temperatures
- TiC-C-SiC is favored at subsolar to solar metallicities and intermediate to high pressures
- Metallicity determines the pressure dependence of graphite condensation

Increasing Metallicity Increases Condensation Temperatures

Starting Condensation Temperatures for TiC, SiC, and C, C/O = 1.2



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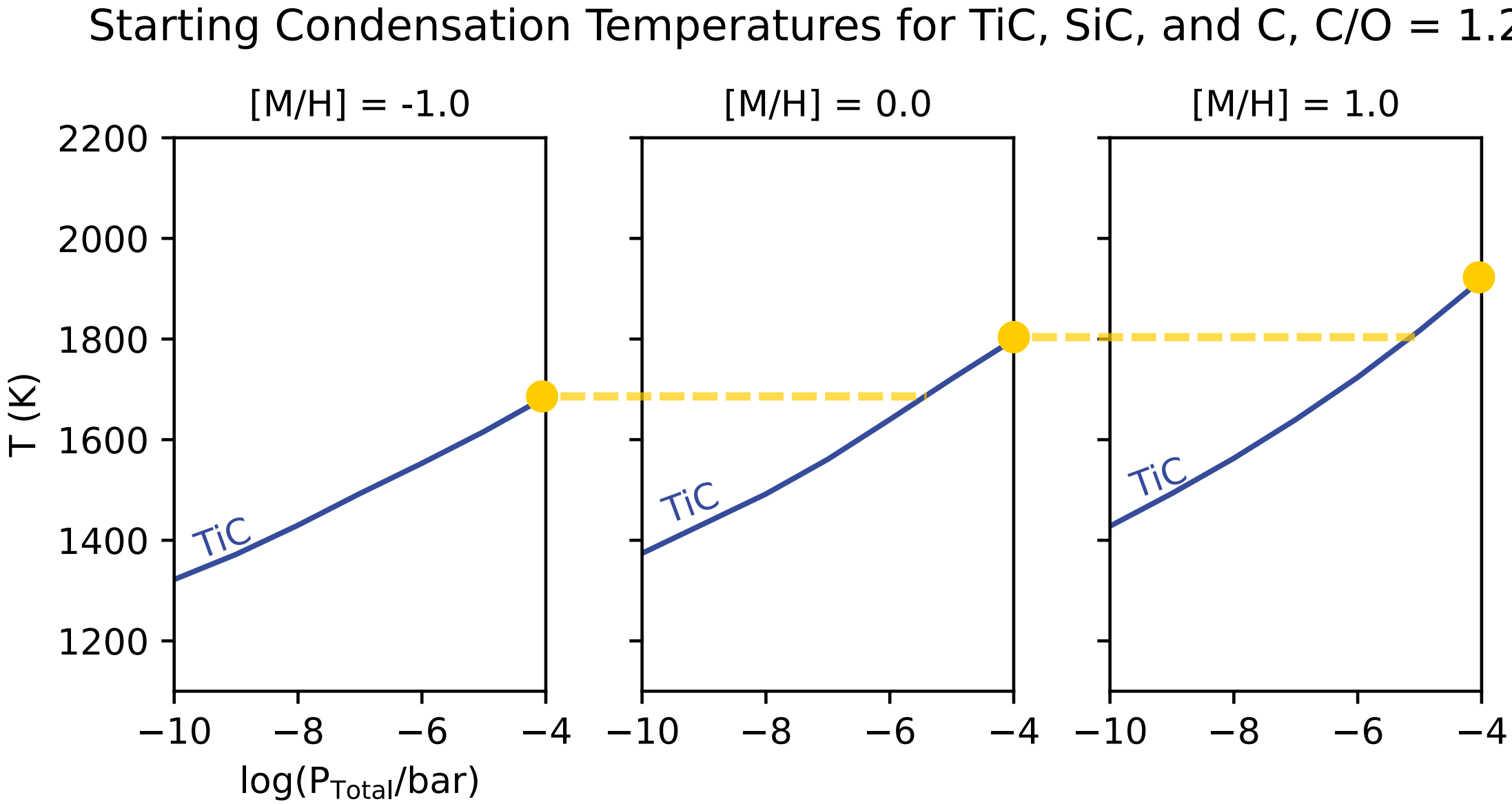

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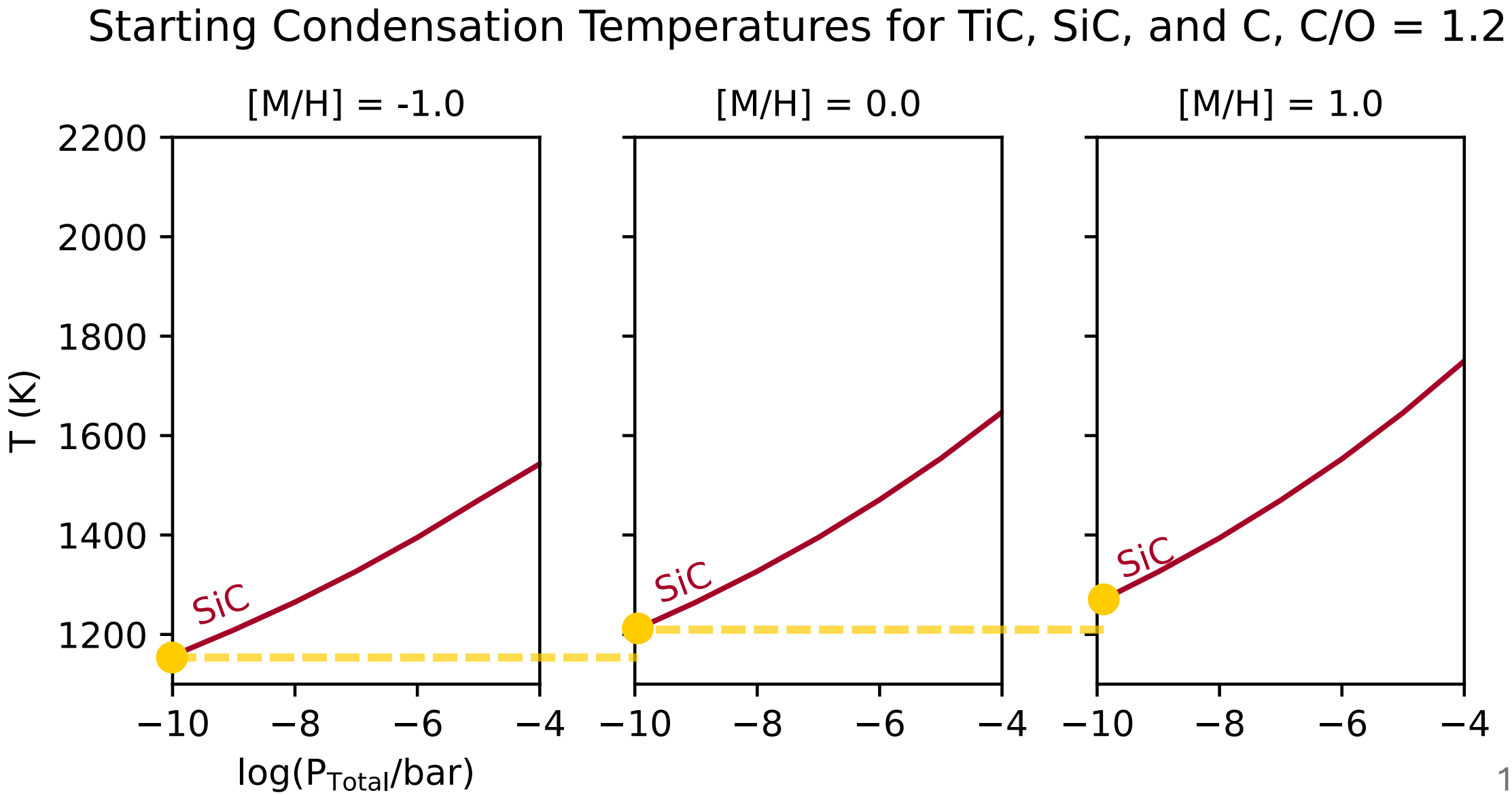
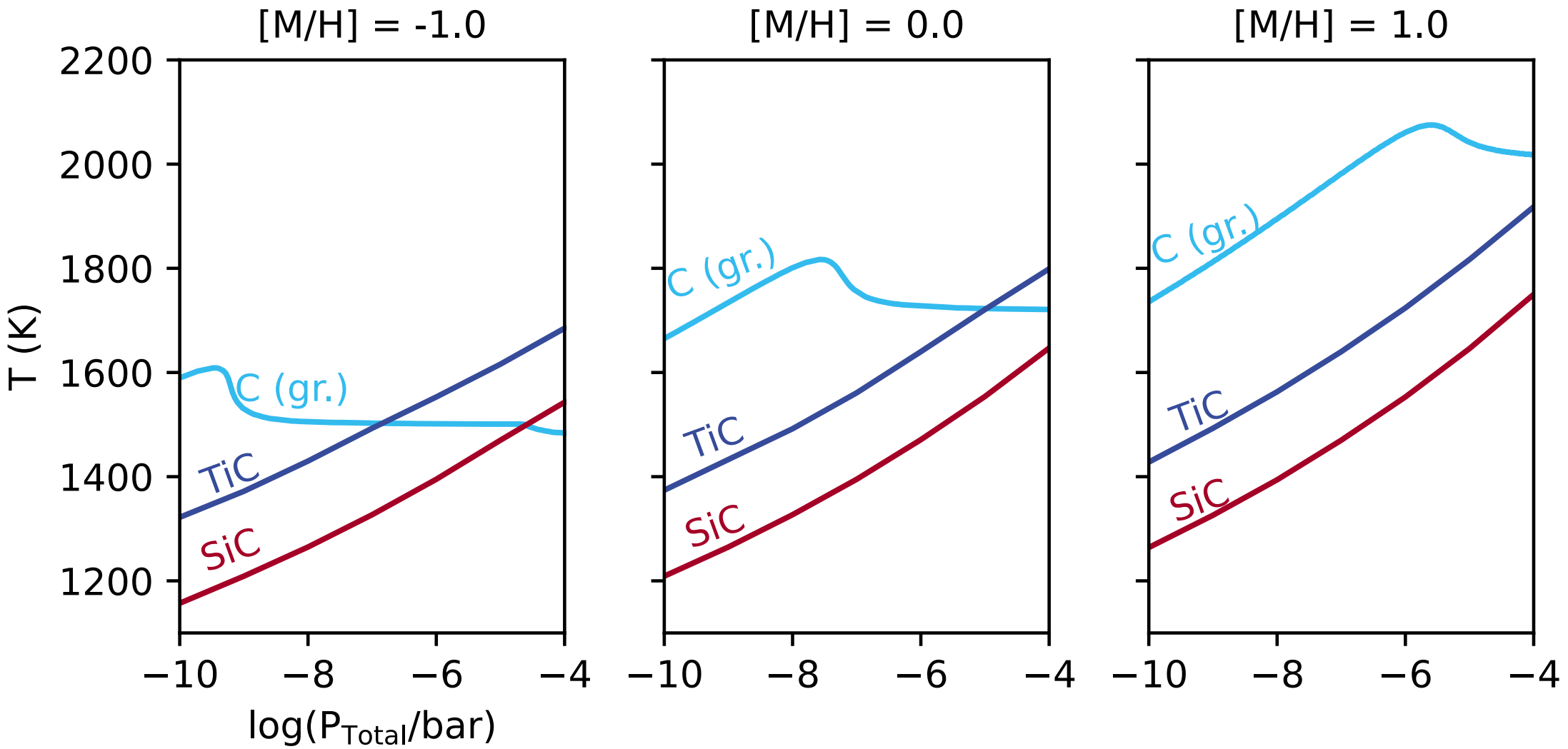


TiC-C-SiC is Favored at Subsolar to Solar Metallicities

Starting Condensation Temperatures for TiC, SiC, and C, C/O = 1.2



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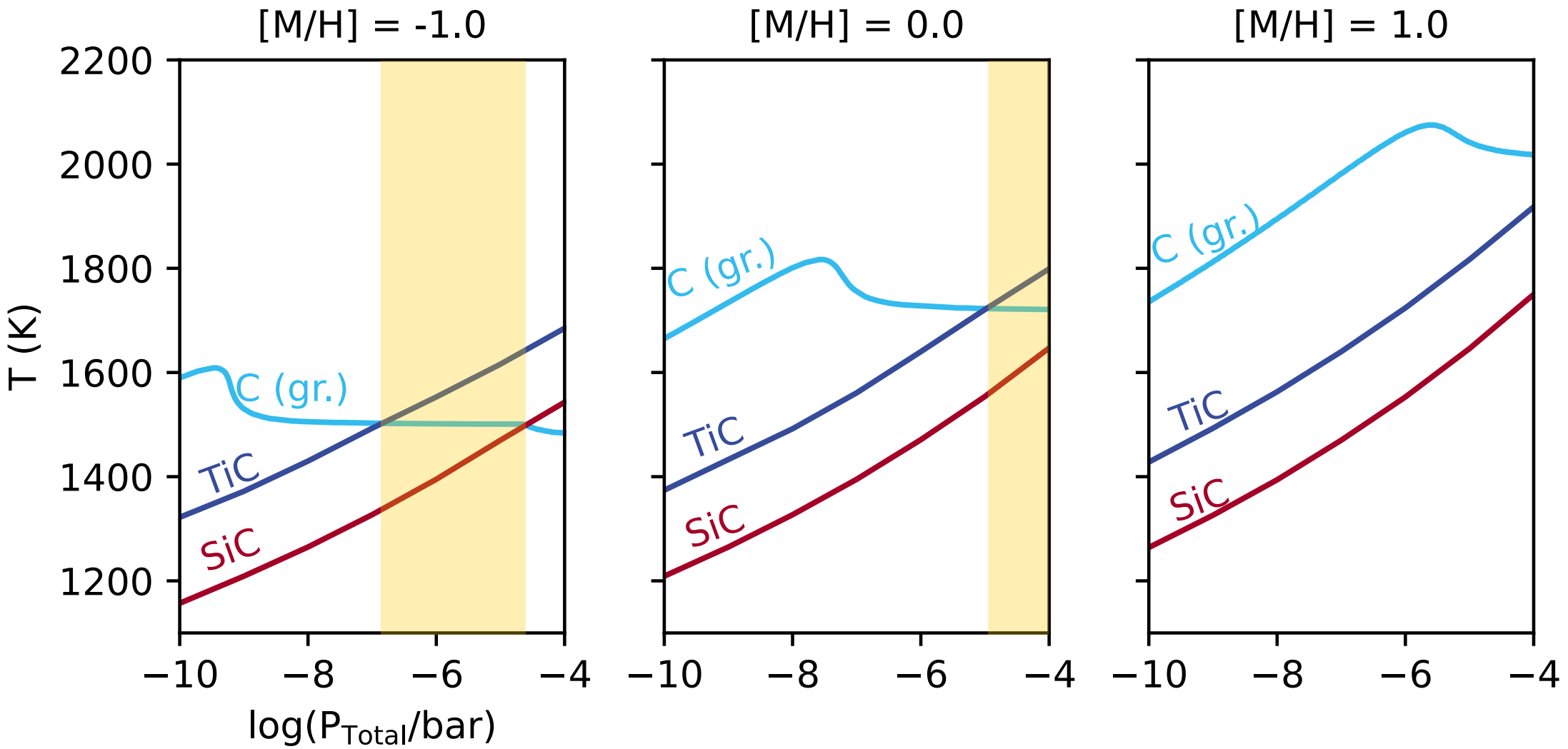
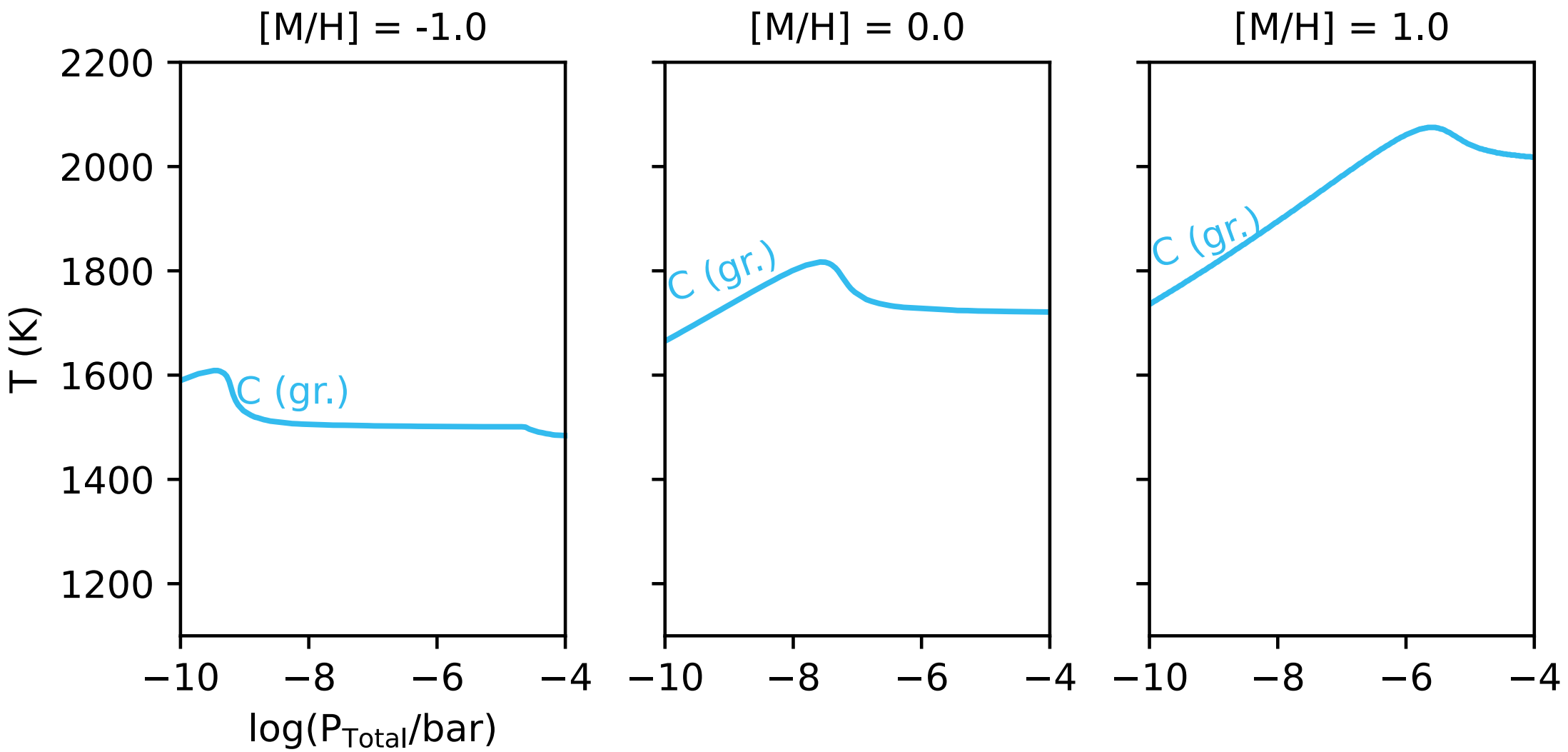


Metallicity Determines the Pressure Dependence of Graphite Condensation

Starting Condensation Temperatures for TiC, SiC, and C, C/O = 1.2



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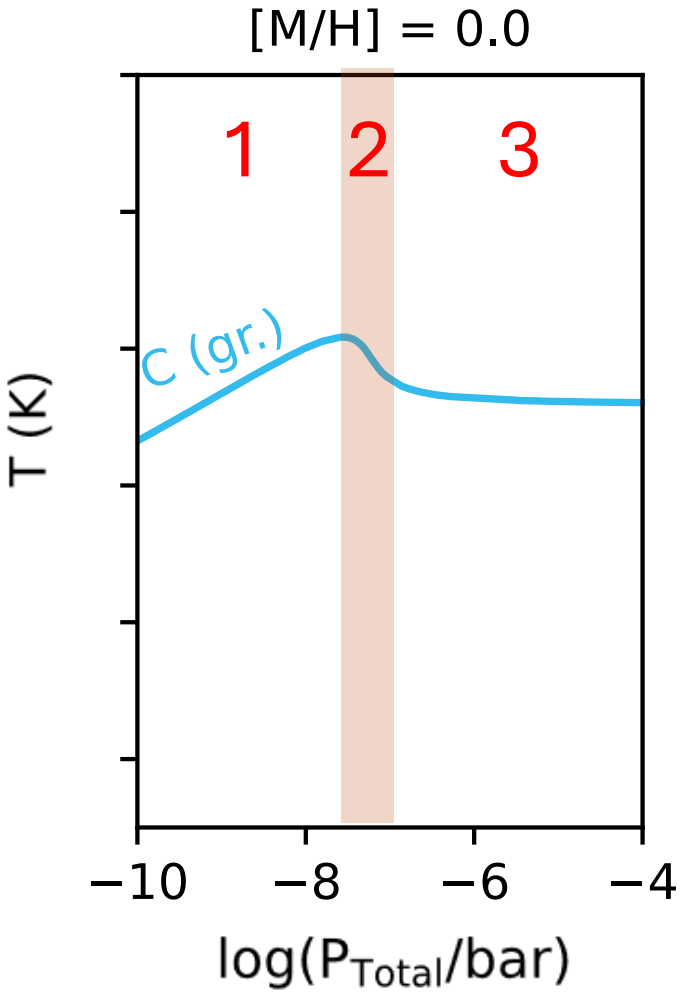
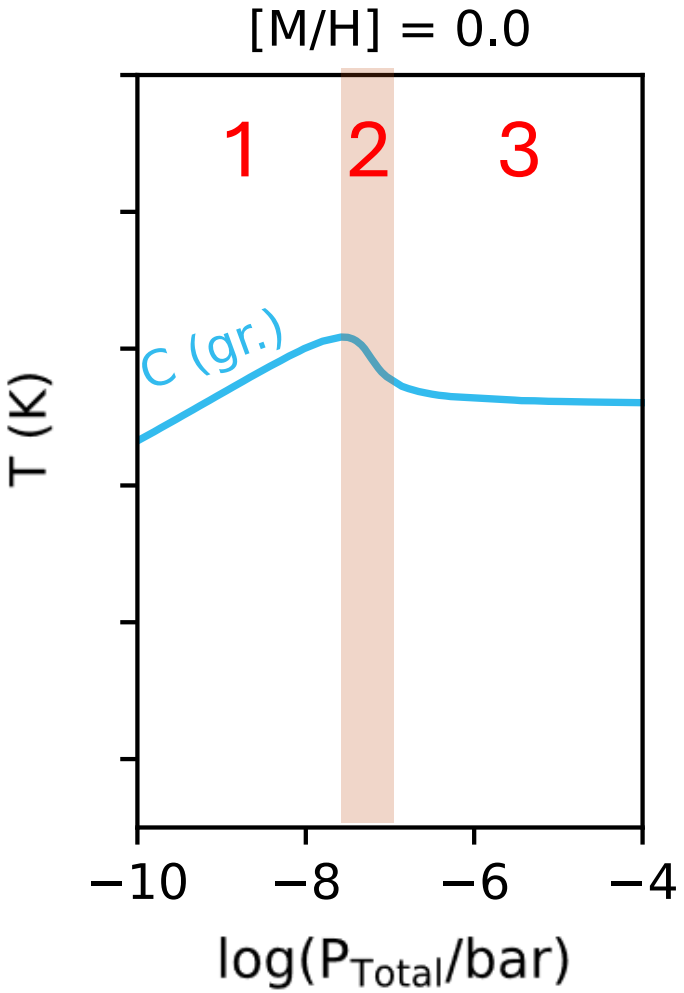


3 Regions

Metallicity Determines the Pressure Dependence of Graphite Condensation

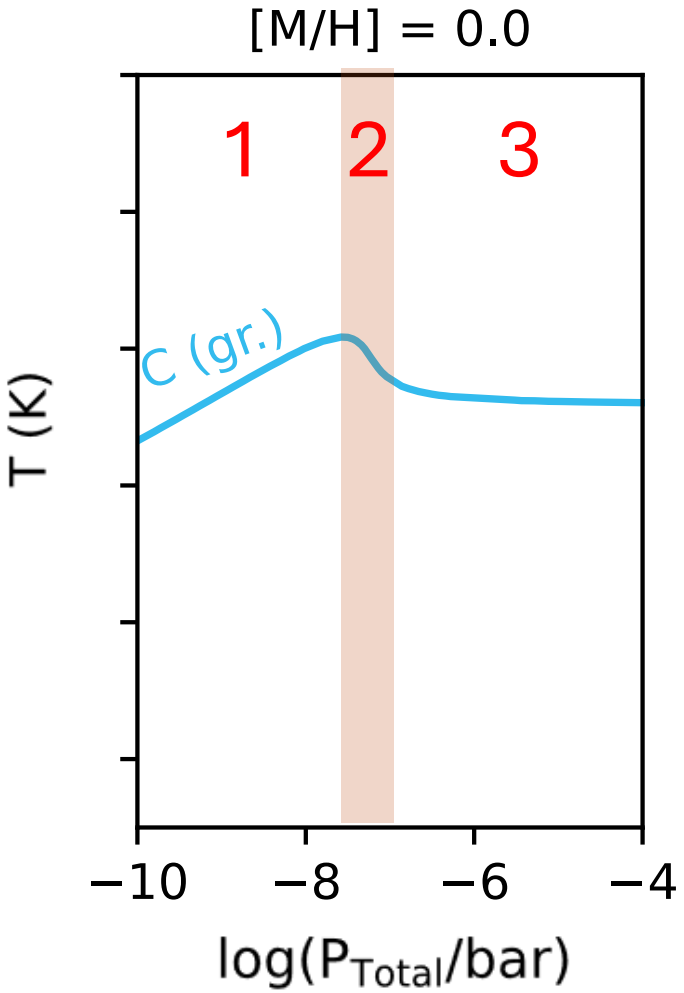


1 Monatomic H and C

2

3

Metallicity Determines the Pressure Dependence of Graphite Condensation



1 Monatomic H and C

2 C_2H_2 and monatomic H

3

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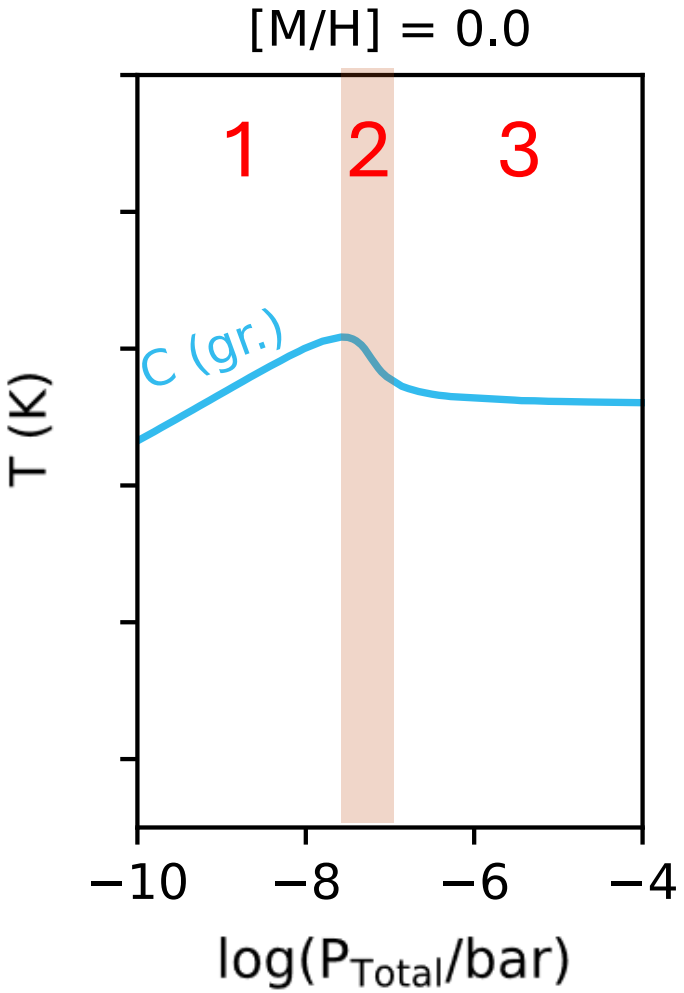

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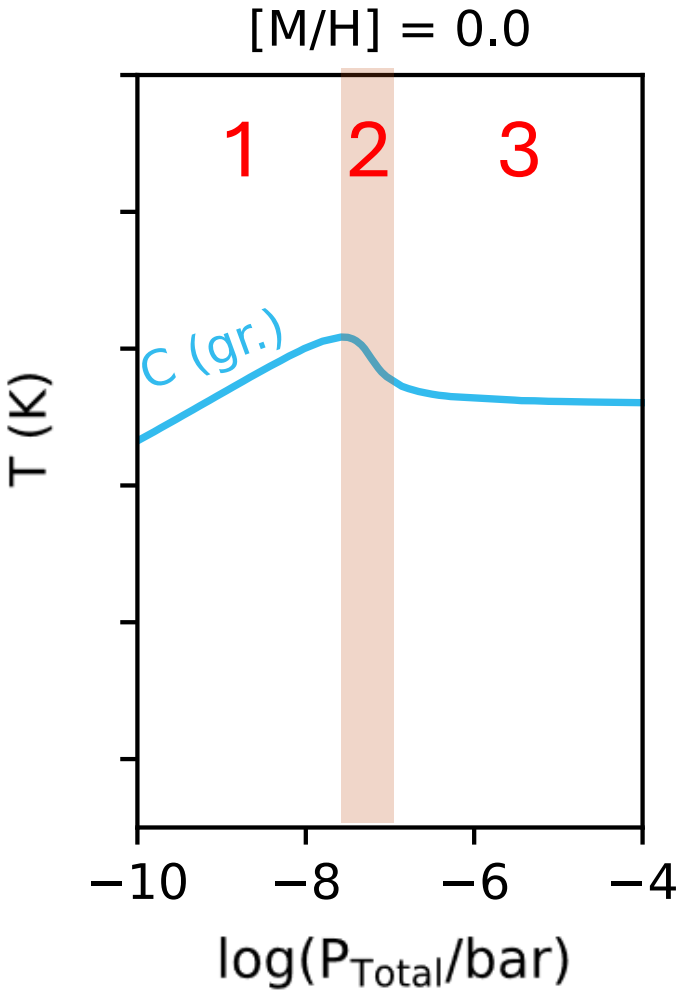
Metallicity Determines the Pressure Dependence of Graphite Condensation

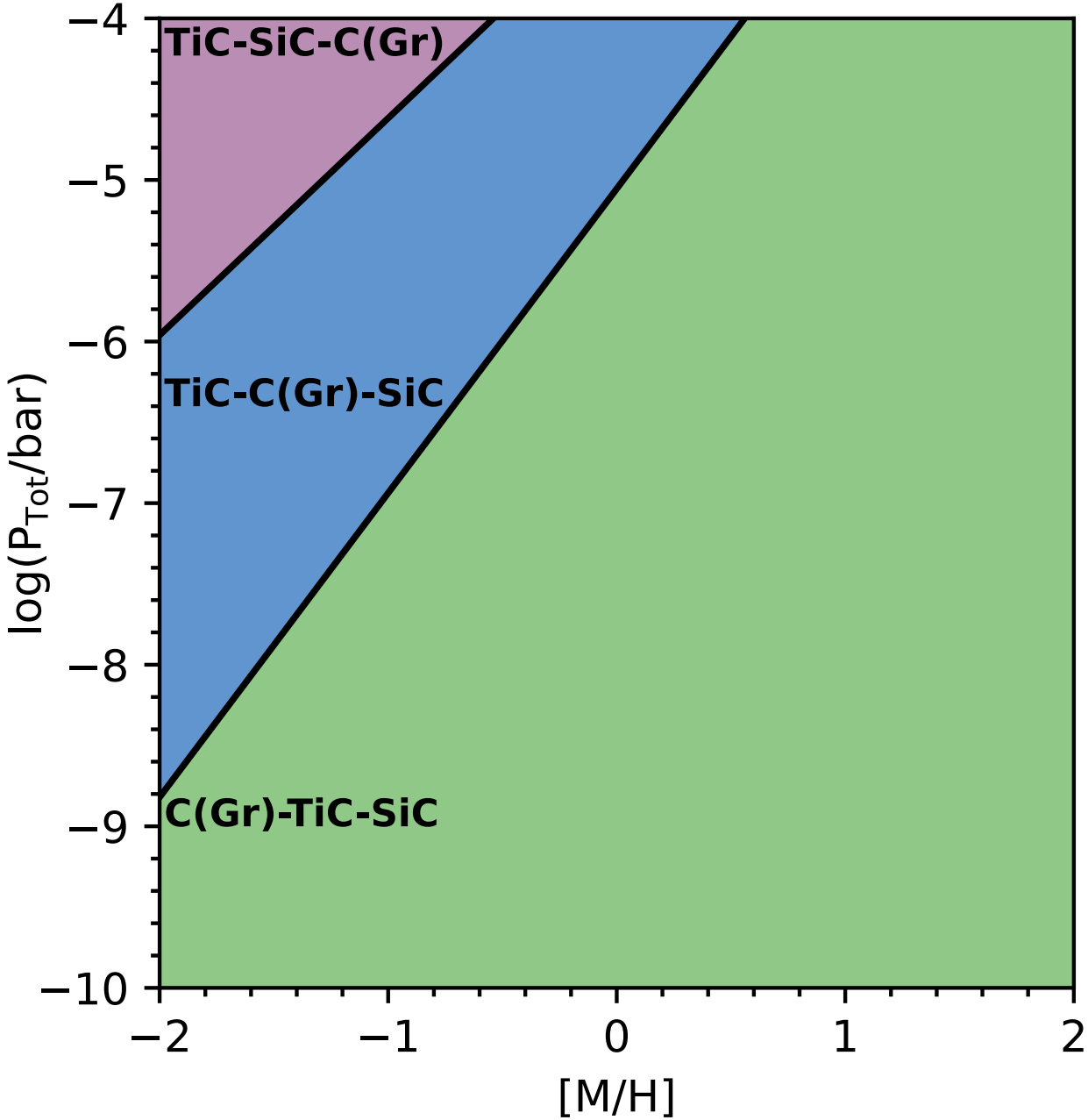


1 $C(g) \rightarrow C(gr.)$

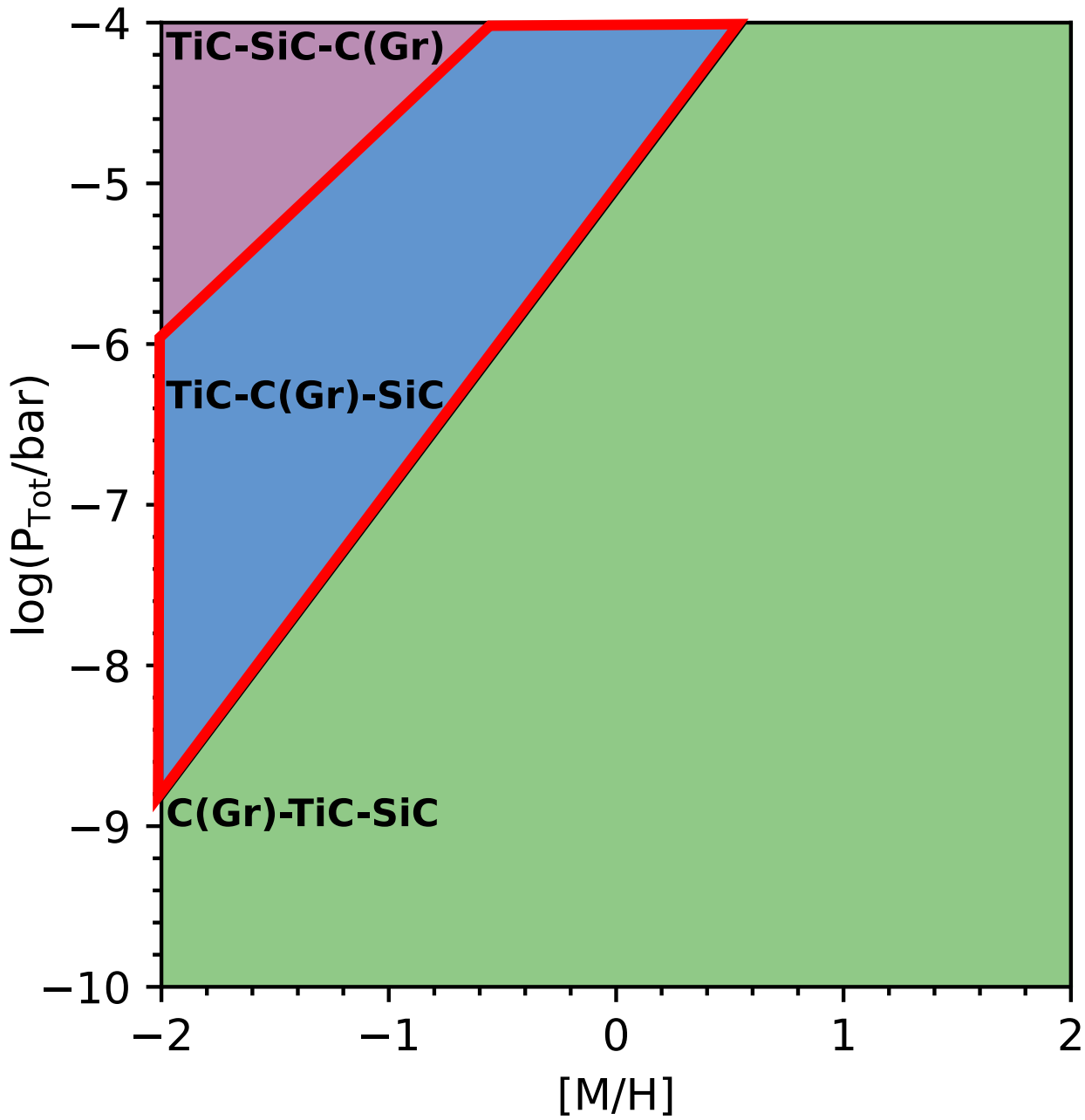
2 $\frac{1}{2}C_2H_2(g) \rightarrow C(gr.) + H(g)$

3 $\frac{1}{2}C_2H_2(g) \rightarrow C(gr.) + \frac{1}{2}H_2(g)$

C-bearing Condensation Sequence



C-bearing Condensation Sequence



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Key points

- Increasing metallicity increases condensation temperatures
- Metallicity determines the gas chemistry, which determines the pressure dependence of graphite condensation
- TiC-C-SiC is favored at subsolar to solar metallicities and intermediate to high pressures

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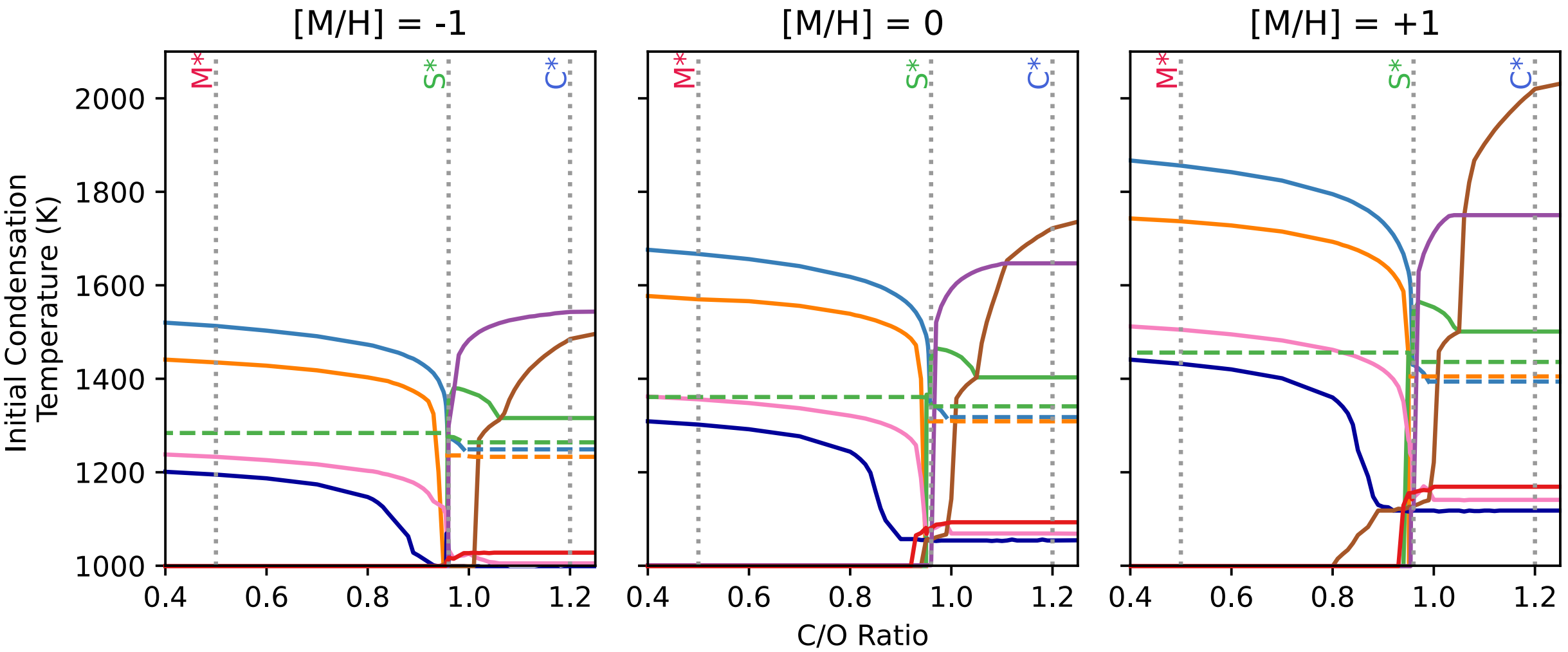
In progress: change C/O ratio and [M/H]



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