Stellar cosmic rays can strongly deplete CO in 1Myr

Chemistry and cosmic rays: the terrestrial planet-forming region of disks

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Summary

- Chemical model of a typical planet-forming disk around a ~solar-like star
- Ionisation due to stellar cosmic rays is included in the chemical model
- Stellar cosmic rays with larger diffusion coefficients can deplete CO at larger distances
- Carbon from CO is placed into hydrocarbon ices, resulting in a suppressed C/O ratio in the gas

Schwarz & Rodgers-Lee (in prep.)

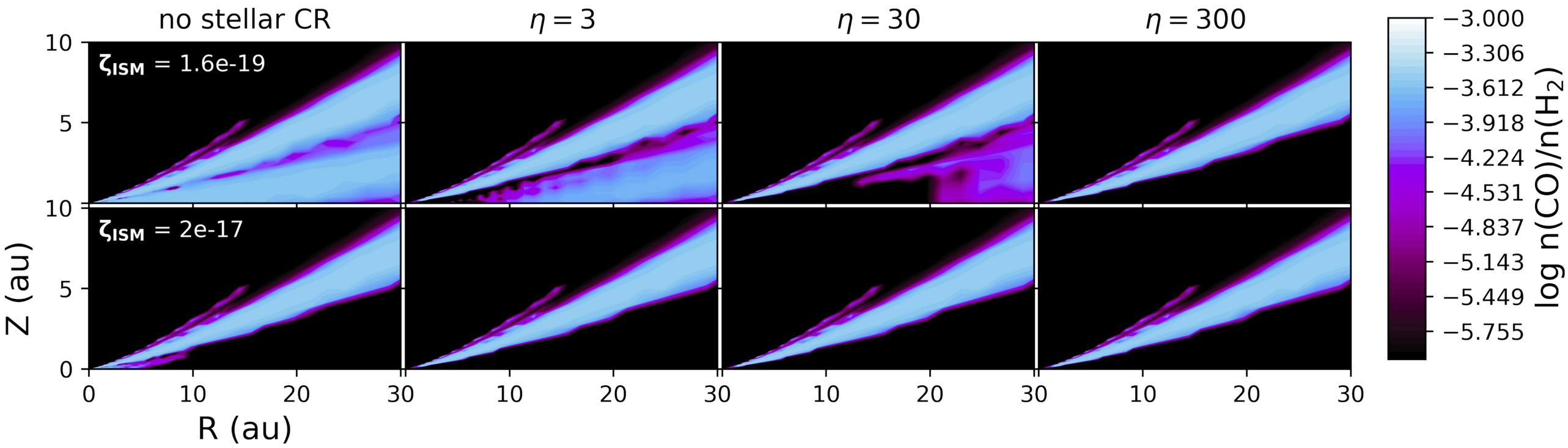

Figure 1: 2D CO abundances for the protoplanetary disk models after 3Myr of chemical evolution with stellar cosmic ray ionisation. Left to right: shows the effect of no stellar cosmic rays and of different stellar cosmic ray transport properties.

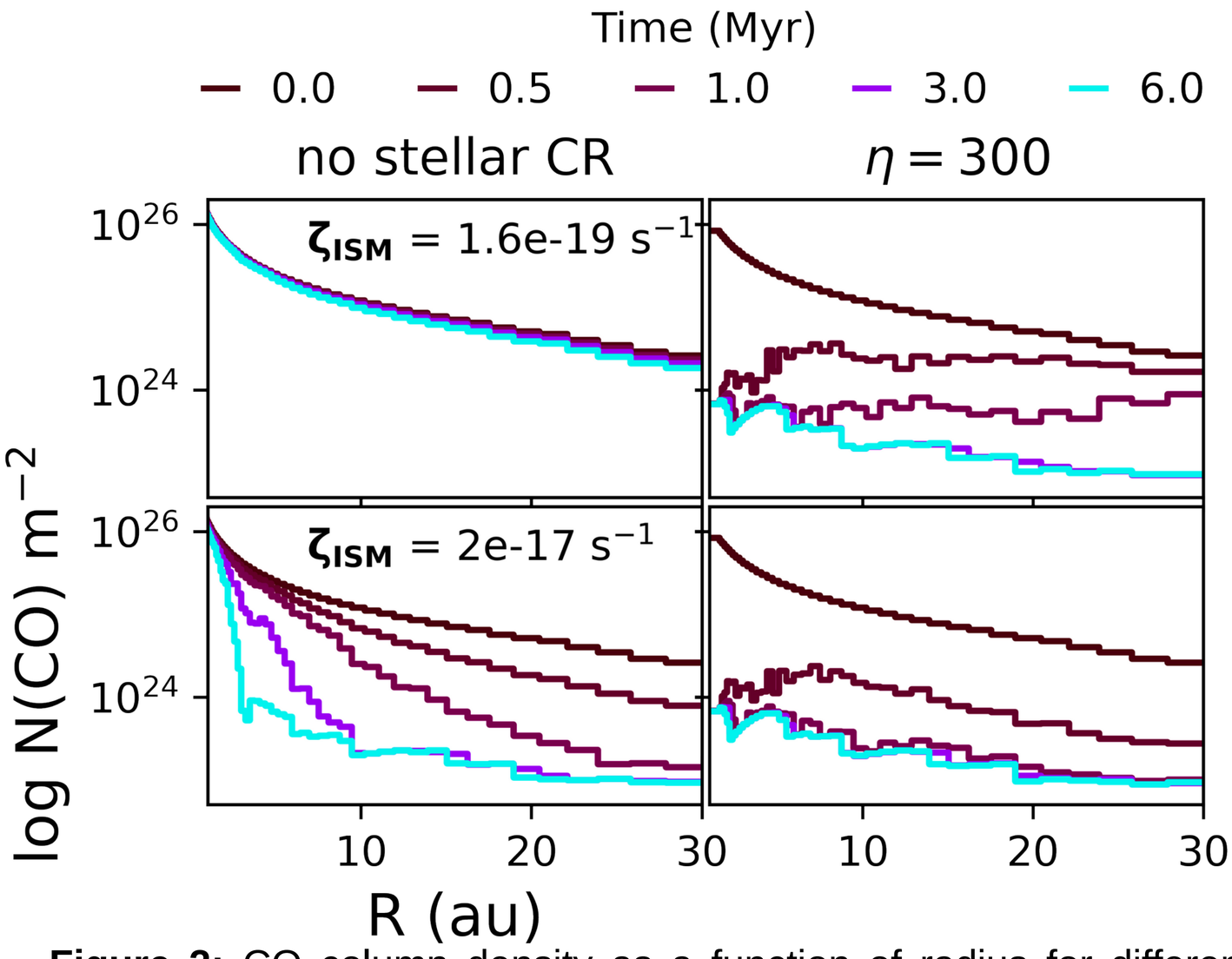

Figure 2: CO column density as a function of radius for different times shown when stellar cosmic rays are (right) and are not included (left) for high and low Galactic cosmic ray ionisation rates.

- Both figures: top and bottom panels include a low and standard Galactic cosmic ray ionisation rate.
- Fig.1: stellar cosmic rays can deplete gas-phase CO close to the disk mid-plane, where other sources of ionisation do not reach, out to ~30au in some cases.
- Fig.2: top right panel shows CO can be depleted by up to 2 orders of magnitude due to stellar cosmic rays on time-scales as short as 1 Myr.
- Chemistry in the terrestrial planet-forming region can be probed with JWST MIRI observations.

Why are CO abundances important?
→ It affects the composition of material that is available to form Earth-like planets