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First Results and Learning from a Global Approach to Compositional Planet Formation

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Global models of planet formation can help to elucidate the link from stellar compositions to planetary bulk composition. I discuss here first results and learnings from a statistical approach to synthesize the (exo)planetary demographics with compositional tracking. First, I show how observed stellar abundances can be translated to grain compositions using constraints from observational astronomy and review uncertainties. Then, the process from dust embedded in a protoplanetary disk to final planets -- via pebbles and planetesimals -- is modeled using the Bern/Heidelberg global model of planet formation. I will outline how a newly developed composition-tracking module is implemented and what planetary bulk compsoitions result.

First results indicate that if a realistic time-lag between emergence of the protoplanetary disk and the first pebble-accreting protoplanets is included, gas accreted onto giant planets is often depleted in molecules with the exeption of ultra-volatile species lilke CO and N_2. For giant planets, but even more so for sub-Neptunes, the bulk of the heavy elements is instead dominated by accreted solids (in the hybrid setting used here, this includes pebbles and planetesimals). For the later evolution up to the present day, but also for the observational properties, determining whether the solids form a distinct core or mix with the envelope is of key importance [1].

[1] Burn, Mordasini, Mishra, Haldemann, Venturini, Emsenhuber & Henning (2024), *Nature Astronomy* 8, 463-471