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Devolatilisation during planet formation: A hybrid model of chemistry and dynamics

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A star and its planets are born from the same molecular cloud, so they share the same origin of the essential building blocks: elements. The compositional deviations between stars and (particularly rocky) planets are associated with the gas-dust fractionation process in the protoplanetary disk and subsequent formation processes of the planets. During these processes, a key differentiator between forming a gas giant (e.g. Jupiter) and a rocky planet (e.g. Earth) is devolatilisation – i.e. depletion of volatiles (e.g. H, C, and O) resulting in completely different bulk compositions between the two types of planets, with former being dominated by gases/ices and the latter by rocks. This devolatilisation mechanism has been empirically observed in both the Solar System and other planetary systems (e.g. in polluted white dwarf atmospheres), but has yet to be explored and implemented in the prevalent planet-formation models.

I will explore both the nebular and post-nebular devolatilization processes based on the first principals starting from the stellar nebulae to rocky planetary bodies. These processes will then be coupled with a state-of-the-art planet formation model. Such a coupled/hybrid devolatilisation-dynamics model will enable a detailed and accurate estimation of the volatile (subject to devolatilisation) and refractory (resistant to devolatilisation) contents of a small (rocky) planet, as well as the physical properties (e.g. mass, radius, and orbit) of the planet. These unprecedentedly detailed predictions of planetary *elemental* composition will provide crucial constraints, together with mass, radius and orbital properties, for further modelling of planetary interiors, surfaces, and atmospheres. Together, these will lead to a new level of predictive statistical understanding of the detailed properties of small (rocky) planets in our solar neighbourhood.