Linking the atmospheric composition of giants planets to their native disc chemistry

Elenia Pacetti (INAF - IAPS)
Diego Turrini, Eugenio Schisano, Sergio Molinari, Sergio Fonte, Romolo Politi

Migrating giant planets visit and accrete material from multiple and compositionally diverse environments in planet-forming discs. The interplay between migration and accretion of gas and solids shapes their composition and leaves fingerprints in their atmospheres. As part of the Consortium activity in preparation to the ESA mission Ariel, we traced these fingerprints in the atmospheric abundances of four chemical elements: C, O, N, and S. We modelled the atmospheric composition of giant planets by coupling detailed planet formation simulations with multiple astrochemical descriptions of the disc environment. We considered both scenarios of inheritance of the disc chemistry from the pre-stellar cloud and complete chemical reset. The disc chemistry strongly influences the partition of C and O between gas and solids, hence preventing unambiguous interpretations of the planetary C/O ratio. Fingerprints of planet formation are nevertheless unveiled when the C/O ratio is compared with other elemental ratios and with the composition of the host star. Giant planets that derive their metallicity predominantly from the accretion of gas are more efficiently enriched in volatile elements than in refractory ones. These planets are characterised by N/O*>C/O*>C/N*, where asterisk denotes normalisation to the stellar value. The exact opposite trend characterises planets that derive their metallicity from the accretion of solids, which are more enriched in refractory elements. The S/N* ratio expands the picture, tracing the planetary refractory-to-volatile ratio. Our methodology has already been applied to the interpretation of spectroscopic observations of six hot and warm Jupiters.