For the first time, hundreds of planetary systems have well constrained planet orbital radii, planet sizes, and masses. In the near future a suite of space missions will identify and characterize thousands of terrestrial and super-Earth like planets on orbits out to roughly year-long periods, both by characterising the planets and their host stars. This new data allows us to delve deeply into understanding the physics which drives the formation of solar systems.

Although the basic dynamics of the gaseous discs around young stars from which planetary systems form (protoplanetary discs) have been well developed in the traditional model of a viscous disk, our rapidly evolving understanding of the physical conditions that prevail in protoplanetary disks dictates that the levels of turbulence found must be small. Importantly, the non-ideal magnetohydrodynamic effects largely suppress magnetohydrodynamic instabilities, leading to an effectively inviscid flow. In lieu of turbulent viscosity, accretion is driven through the disk by a magneto-thermal wind. Acceptably modelling the flow in these effectively inviscid discs requires much higher resolution than in a disc with significant turbulent viscosity. In turn, this demands the use of HPC resources.

We are undertaking a campaign of very high resolution hydrodynamic simulations to address the newly appreciated inviscid and wind driven nature of protoplanetary discs. I will present an overview of the fundamental features which drive the radial migration of planets forming in protoplanetary discs to and away from the central star, and show how our new simulation campaign, enabled by PRACE Tier-0 resources, promises to alter our conception of how solar systems form.

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