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Global simulations of protoplanetary discs with Ohmic resistivity and ambipolar diffusion

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As the nurseries of planetary systems, protoplanetary discs are of key interest to planet formation theory. Their dynamics and structure depend critically on the influence of magnetic fields. Being comparatively cold and dense, the physical state of the disc plasma is dominated by external ionizing X-ray and cosmic-ray radiation, leading to a layered vertical structure – with turbulent, magnetised surface layers and a magnetically-decoupled midplane.

This 'dead-zone' picture is further complicated by ambipolar diffusion, which is expected to dominate in the tenuous hot corona of the disc and within the low-density gaps opened by protoplanetary cores. With ambipolar diffusion included, it is expected that parts of the disk will be stabilized and a magnetically-driven wind will be launched. This has so far only been studied in simplified local models that neglect the global structure of the protoplanetary disc. The recognition of the importance of additional non-ideal effects such as ambipolar diffusion or Hall effect has led to serious questioning of the paradigm of magneto-rotational turbulence and has renewed interest in the role played by disk winds and purely hydrodynamic instabilities. The former are best studied in a global disc model. We present results from the first global simulations that include the effect of ambipolar diffusion and show the launching of a magneto-centrifugal wind.

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