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Hyper-global zoom-in simulations of protostellar disc formation

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We use the adaptive mesh refinement computer code RAMSES to model, for the first time, the formation of protoplanetary disks in realistic star formation environments, with resolution scaling over a billion, covering a range from outer scales of about 50 pc to inner scales of less than 0.01 AU. The models are done in three steps, with the first step having a dynamic resolution of ~65,000, following individual star formation in a GMC model. In the 2nd step, the neighborhoods of several stars with a final system mass of 1-2 solar masses are followed during the accretion process, with a smallest mesh size of 2.5 AU, sufficient to follow the development of the large scale structure of their accretion from the environment to the disks. Finally, a selection of these disks are studied over shorter time intervals, of the order 100-1000 yr, with cell sizes ranging down to 0.01 AU, sufficient to resolve the vertical structure of a significant radius fraction of the disks.
The purpose of this procedure is to characterize the typical properties of accretion disks around solar mass protostars, with as few free parameters as possible, and to gather a statistical sample of such conditions, to quantify the extent of statistical variation of properties. This is a vast improvement over models where initial and boundary conditions have to be chosen arbitrarily. Here, the initial and boundary conditions follow instead from the statistical properties of the interstellar medium, which are reasonably well established, as per for example the Larson relations on large scales.

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