Planet-forming disk population properties from simulations to observations

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Protoplanetary disks, which are essential consequence of the gravitational collapses of molecular cloud cores, host the formation of planetary systems known today in our universe. So far, the properties of these disks have been studied extensively, yet separately, either by numerical simulations from certain initial conditions or by observations of their dust continuum and line emission from specific molecular tracers. In this study, we provide a first attempt to compare the accuracy of some critical disk parameters, as derived on real ALMA observational data, with the corresponding physical parameters that modelers can directly define in numerical simulations. The approach we follow is to provide full post-processing of the numerical simulations and apply on the synthetic observations the same techniques used by observers to derive the physical parameters. To that end, we performed 3D Monte-Carlo radiative transfer and interferometric simulations of the disk populations formed in numerous MHD simulations of the disks' formation through the collapse of massive clumps [1] with the tools RADMC-3D [2] and CASA [3], respectively, to obtain their synthetic observations. With these observations, we re-employ the models commonly used in disk modelling from their continuum emissions [4] to infer their properties that one would likely get if one observed them with real interferometers. We then demonstrate how their properties, namely their sizes and masses, vary from the gas kinematics analyses to the dust continuum modelling and provide implications for the possible uncertainties in the modelling of these objects from observations.

Références

[1] Lebreuilly, U., Hennebelle, P., Colman, T., et al. 2021, ApJL, 917, L10. doi:10.3847/2041-8213/ac158c

[2] Dullemond, C. P., Juhasz, A., Pohl, A., et al. 2012, Astrophysics Source Code Library. ascl:1202.015

[3] McMullin, J. P., Waters, B., Schiebel, D., et al. 2007, Astronomical Data Analysis Software and Systems XVI, 376, 127

[4] Maury, A. J., Andr´e, P., Testi, L., et al. 2019, A&A, 621, A76. doi:10.1051/0004-6361/201833537