Visualization and Analysis of Synthetic Observations of Embedded Protostellar Outflows

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\textbf{Summary}

We present 3D visualizations used for the analysis and exploration of synthetic observations and in comparing synthetic with real observational data cubes. By comparing synthetic observations (i.e., position-position-velocity cubes) to the original simulation output (i.e., position-position-position cubes) utilizing 3D visualization techniques we are able to more effectively and efficiently compare these types of data, in particular kinematic structures such as outflows. We investigate simulations performed with the ORION adaptive mesh refinement (AMR) three-dimensional gravito-radiation-hydrodynamics code, which follows the collapse and evolution of protostars with outflows down to AU size scales. The $^{12}$CO synthetic observations are produced using MOLLIE, a molecular line radiative transfer code. Comparing the 2D column maps, 3D p-p-v cubes, synthetic $^{12}$CO p-p-v cubes, and 3D p-p-p cubes allows us to connect real and observed physical structures and enhance the interpretation of astronomical data cubes. For instance, in the pictured example we can see smaller outflows ejected by companion protostars which may be hidden within the data at the current level of observational accuracy.

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