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Generalized Beltrami-Bernoulli Flow Model for Astrophysical Disk-Jet Structure Formation

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In the vicinity of a massive object of various scales (ranging from young stars to galactic nuclei), mass flow creates a spectacular structure combining a thin disk and collimated jet. Despite a wide range of scaling parameters, they exhibit a remarkable similarity that must be dictated by a universal principle. A generalized Beltrami condition has been formulated as a succinct representation of such a principle. The singularity at the center of the Keplerian rotation forces the flow to align with the "generalized vorticity"(including the effect of localized density and finite dissipation) which appears as an axle penetrating the disk –hence, the collimated jet is a Beltrami flow. An analytical expression of a disk-jet system has been constructed. Employing the Beltrami-Bernoulli flow configuration of disk-jet structure we apply our model for the analytic description of hydrodynamic jets from protostellar disks. For this purpose, we extend the standard turbulent viscosity prescription and derive several classes of analytic solutions using the flow parametrization in self-similar variables. Derived solutions describe the disk-jet structure, where, for the first time, jet properties are analytically linked with the properties of the accretion disk flow. These solutions can be used to analyze the astrophysical jets from protostellar accretion disks and link the properties of outflows with the local observational properties of accretion disk flows.

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