Generalized Beltrami Flow - a Model of Narrow-jet and thin-disk system

Nana Shatashvili [a,b] *and Zensho Yoshida* [c]

E-mail: nana.shatashvili@tsu.ge

[a] Department of Physics, Faculty of Exact and Natural Sciences, Iv. Javakhishvili Tbilisi State University, Tbilisi 0179, Georgia

[b] TSU Andronikashvili Institute of Physics, Iv. Javakhishvili Tbilisi State University, Tbilisi 0177, Georgia

[c] Graduate School of Frontier Sciences, The University of Tokyo, Chiba 277-8561, Japan

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 (such as Reynolds number, Lundquist number, ionization fractions, Lorentz factor, etc.), 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, i.e. the jet is a Beltrami flow. Based on the Beltrami flow model, an analytical expression of a disk-jet system has been constructed by the method of similarity solution. The *helicity* of the *generalized vorticity* is the key parameter that characterizes the self-organizing of a disk-jet system. Although the present study describes a pure fluid-mechanical model of jet collimation, conventionally considered magnetic field, thrusting the center of the disk, to "guide" (and twist, as often observed) the flow of charged gas (plasma), can be easily invoked. Here the *fluid generalized vorticity* plays the same role of *a magnetic field*.