Contribution ID: **22** Type: **Invited talk in a parallel session**

# Relativistic viscous accretion flow model for black hole sources with XMM–Newton observations

*Thursday, 11 July 2024 17:30 (30 minutes)*

We develop a model formalism to study the structure of a relativistic, viscous, optically thin, advective accretion flow around a rotating black hole in presence of radiative coolings. We use this model to examine the physical parameters of four black hole Ultra-luminous X-ray sources (BH-ULXs), namely mass ($M_{\rm BH}$), spin ($a_{\rm k}$) and accretion rate ($\dot{m}$), respectively. While doing this, we adopt a recently developed effective potential to mimic the spacetime geometry around the rotating black holes. We solve the governing equations to obtain the shock induced global accretion solutions in terms of $\dot{m}$ and viscosity parameter ($\alpha$). Using shock properties, we compute the Quasi-periodic Oscillation (QPO) frequency ($\nu_{\rm QPO}$) of the post-shock matter, when the shock front exhibits Quasi-periodic variations. We also calculate the bolometric luminosity ($L_{\rm bol}$) of the entire disc for these shock solutions. Utilizing $\nu_{\rm QPO}$ and $L_{\rm bol}$, we constrain BH-ULXs mass by varying their spin ($a_{\rm k}$) and accretion rate ($\dot{m}$). We find that NGC6946 X$-$1 and NGC5408 X$-$1 seem to accrete at sub-Eddington accretion rate provided their central sources are rapidly rotating, whereas IC342 X$-$1 and NGC1313 X$-$1 can accrete in sub/super-Eddington limit irrespective to their spin values.

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**Session Classification:** Spectral and temporal properties of accretion flows and jets around compact objects and the theoretical models

**Track Classification:** Accretion (AC): Spectral and temporal properties of accretion flows and jets around compact objects and the theoretical models