POSSIBILITY AND NECESSITY OF OBSERVING ULXs in UV

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Ultra-Luminous X-Ray Sources (ULXs)

- 1988 *Fabbiano*

  Discovery of variable, unusually high X-ray flux point sources in nearby starburst galaxies with *EINSTEIN*

- Present observations

  - Variability on time-scales as low as 10^4 s suggested accretion onto black holes in a binary
  - Assuming isotropic emission, X-ray fluxes in excess of $\sim 10^{39}$ erg s^{-1}
  - Non-nuclear locations, hence unrelated to AGN activity
  - Unresolved at ~0.”5, do not have radio-counterparts, ruling out close aggregates or young supernovae

Eddington luminosity

(at which the radiation forces balance gravity) is

$L_{Ed}=1.3 \times 10^{38}\ (M/M_{sol})$ erg s^{-1}

- For a neutron star, $L_{Ed}\sim 2\times10^{38}$ erg s^{-1}
- For a stellar-mass BH , $L_{Ed}\sim(0.4\text{-}2)\times10^{39}$ erg s^{-1}

to have luminosities at or below L_{Ed}, and if beaming of emission is moderate to negligible, the ULXs must have

$$2\times10^{38} < L_X < 10^{41} \text{ erg s}^{-1}$$

(Bright Seyfert galaxies: 10^{42} – 10^{44} erg s^{-1})

***Main Conclusion**: accreting object is IMBH with mass*

$$15\text{—}1000\ M_{sol} < M_{IMBH} < 10^5\ M_{sol}$$

Importance of IMBHs

A link between stellar and SM black holes:

- *stellar-mass black holes*

  $5—30\ M_{sol}$

- *super-massive black holes*

  $10^6—10^9\ M_{sol}$

Cosmologically:

- May contribute as much as $\Omega \sim 0.02$ to the cosmic baryon budget (for SMBHs $\Omega \sim 10^{-5.7}$)
- Can be remnants of Population III stars

Models of ULXs

- IMBHs binaries emitting quasi-isotropically at or near Eddington luminosity;

the strongest evidence so far is existence of strong narrow QPOs and Fe Kα line in M82 X-1 ULX.

- Stellar-mass black hole binaries emitting below L_{ed} but strongly beamed towards us;

Systems like SS433 viewed along the axis can emit bolometrically upto 10^{41} erg s^{-1} if the collimation factor b ~10%

$$L=10^{40}\, b^{-1} \text{ erg } s^{-1}$$

- Stellar-mass black hole binaries emitting quasi-isotropically, but much above L_{ed}

UV observations of ULXs

never done

Both beamed and unbeamed models are expected to be bright UV sources: *accreting IMBHs* due to decreasing of the accretion disk T with the increase of the accretor mass, and *beamed models* due to the radiation reprocessing with the outflowing matter.

X-ray spectrum does not easily distinguish between models.

Multi-wavelength observations of ULXs are necessary!!!

✓ Beamed models tend to predict different spectra than unbeamed models

✓ Identification of an UV/optical/IR companion may help to determine the mass function---a crucial low limit on BH mass

Many ULXs are associated with early-type stars;

optical nebulae and optical SNR.

Multi-wavelength observations may allow better estimates of the overall luminosities of ULXs rather than their isotropic equivalent luminosities.

Radial velocity measurements are possible of the companion, thus determining mass function.

Multiband UV photometry can for the first time detect the UV emission of ULX accretion disks.

Measuring the spectral slope in UV can give valuable information on source properties.