New X-Ray Clues

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Why in News?

Researchers from the Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital published a study analyzing broadband X-ray emissions from four classical high-energy blazars.

Target Objects

- **Target Blazars** - Studied four classical **TeV blazars** (active galaxies emitting very-high-energy gamma rays at tera-electronvolt scales):
  - **Mrk 421** (Markarian 421)
  - **Mrk 501** (Markarian 501)
  - **PG 1553+113**
  - **PKS 2155-304**
- **Space Telescopes Combined**
  - **NASA's NICER (Neutron star Interior Composition Explorer) -** Captured lower-energy (soft) X-ray spectra.
  - **NASA's NuSTAR (Nuclear Spectroscopic Telescope Array) -** Captured higher-energy (hard) X-ray spectra.

Key Astrophysical Findings

- **Detection of Accretion Flow Contribution**
  - In standard blazar models, X-ray emission is completely dominated by intense, beamed non-thermal radiation from the **relativistic jet** pointed toward Earth.
  - When **Mrk 421** and **Mrk 501** entered moderate-to-low active (quiescent) states, researchers detected an additional low-energy spectral component.
  - This confirms that when jet emission dims, thermal/non-thermal radiation from the **accretion disk** surrounding the black hole becomes observable—providing the **first evidence of a direct accretion disk contribution in Mrk 501** (and confirming earlier hints in Mrk 421).
- **Unresolved Gaussian Feature in Mrk 421 -** A minor extra emission peak (Gaussian feature) was detected in Mrk 421's spectrum.
- It indicates localized energy excess (potentially linked to instrumental artifacts or localized magnetic activity near the jet base).
- **Curved Spectral Profile in Other Blazars -** For PG 1553+113 and PKS 2155-304, the X-ray spectra strictly followed standard synchrotron models.
- The curved spectral shape reflects differential rates of particle energy gain (acceleration) versus radiative loss.

Significance for Active Galactic Nuclei (AGN) Physics

- It challenges the traditional assumption that blazar X-rays originate purely from jet dynamics, establishing that AGN X-ray spectra are multi-component systems influenced by accretion state transitions.
- It enables astronomers to disentangle how central accretion disks feed matter into supermassive black holes while simultaneously launching relativistic jets.

Reference

DST | New X-Ray clues from blazars