Rapid radio variability in black hole and neutron star X-ray binary jets

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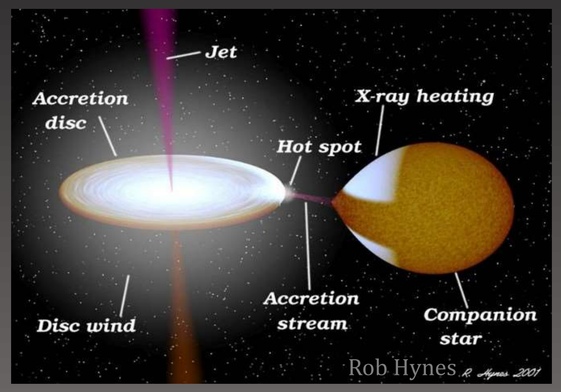
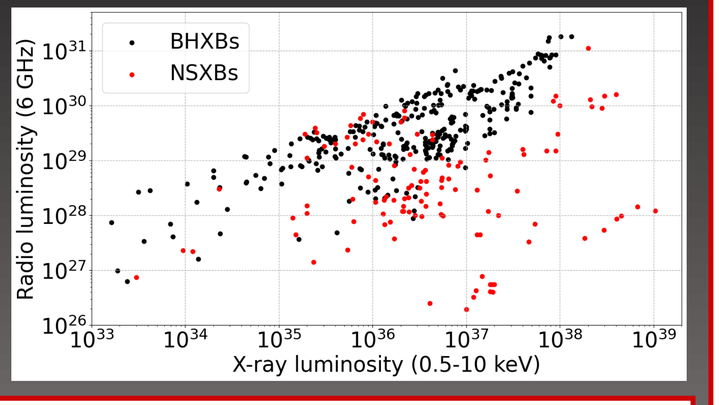
X-ray binaries

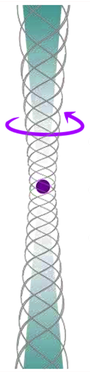
- **Black holes (BH) or neutron stars (NS) accreting from a binary companion**
- **Material enters accretion disk, then either accreted onto BH/NS** (observed in X-ray) **or ejected from system via winds or relativistic jets** (observed in radio)
- **Many open questions as to the geometry and processes at work in an extreme environment** (high gravity, temperature, velocity, magnetic field ($\vec{B}$))





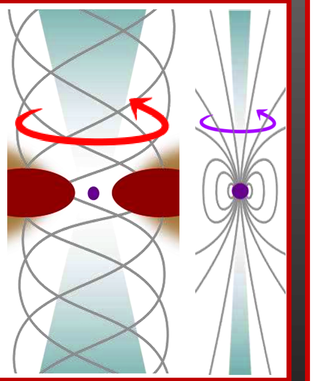
BH vs. NS jets

- **Observationally, NS jets generally much fainter** (factor of ~100)
- **Potentially related to different jet launching mechanisms**
- **But how similar or different are their jet structures?**



Jets are believed to be collimated and accelerated by $\vec{B}$
Theoretical jet launching mechanisms:

- **BH: Nearby $\vec{B}$ caught in frame dragging of spinning BH**
- **NS: Produce own $\vec{B}$ and rotate**
- **Both: $\vec{B}$ anchored in rotating accretion disk**



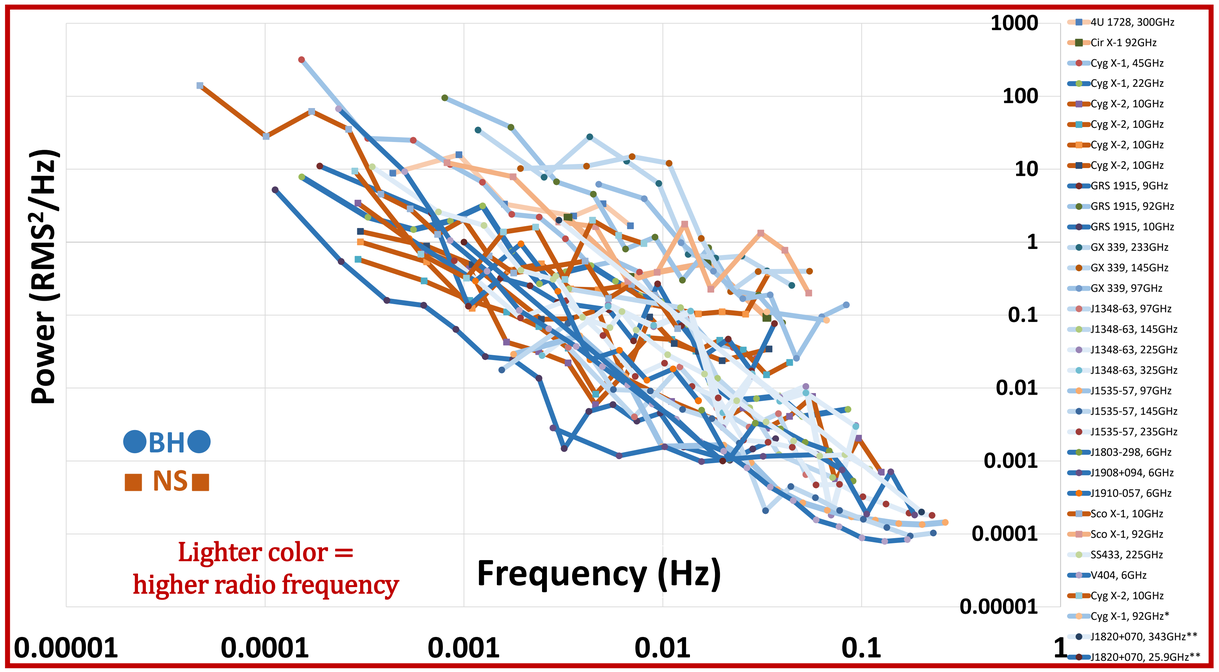
Blandford+77, Blandford+79, Blandford+82, Fender+04, Done+07, McClintock+11, van den Eijnden+21, Tetarenko+21

Radio variability project

- **Cannot directly image most BH/NS jets → use timing analyses instead,** such as power spectral densities (PSDs)
- **Compare radio PSDs of BHs and NSs to look for general similarities or differences, tracing back to jet properties** (e.g., speed, opening angle)

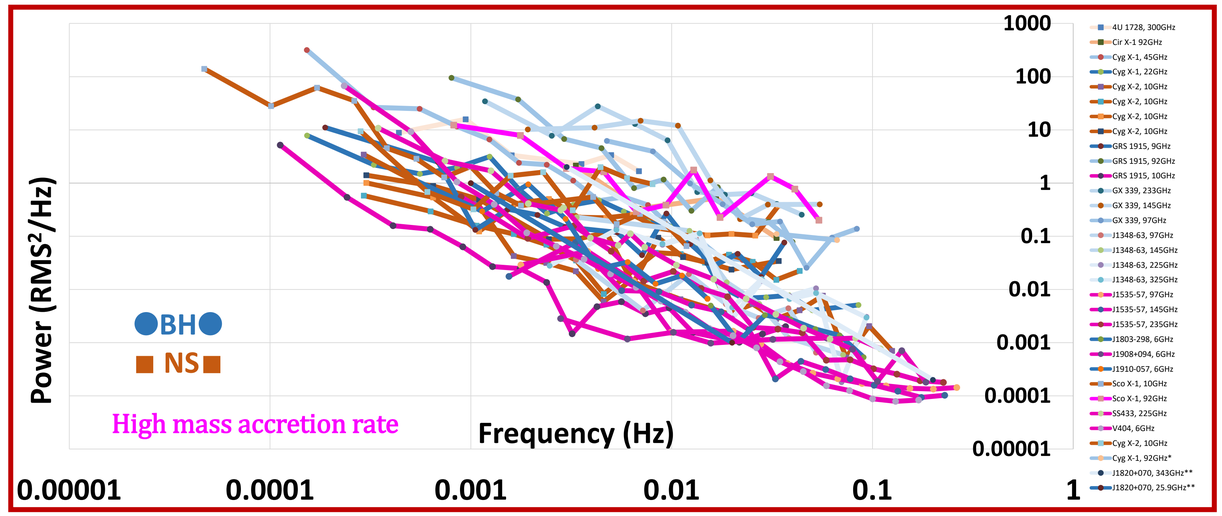
Current PSD results

- **Power spectral densities show remarkably similar levels of variability between both BH and NS jets – surprising?**



- **Despite a large difference in radio luminosity, perhaps BH and NS jets are not so different after all! More observations (especially NS) needed.**

- **Bonus: Magenta are high mass accretion rate observations – tend to have low radio variability even at high frequencies**



- **High accretion rate systems known to have different jet structures than low accretion rates, which is also indicated here with lower variability**