



Multi-frequency variability of OJ 287

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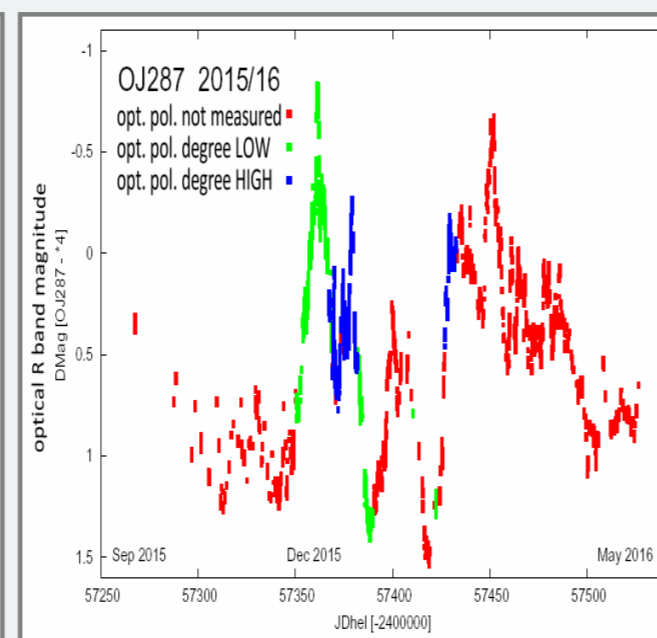
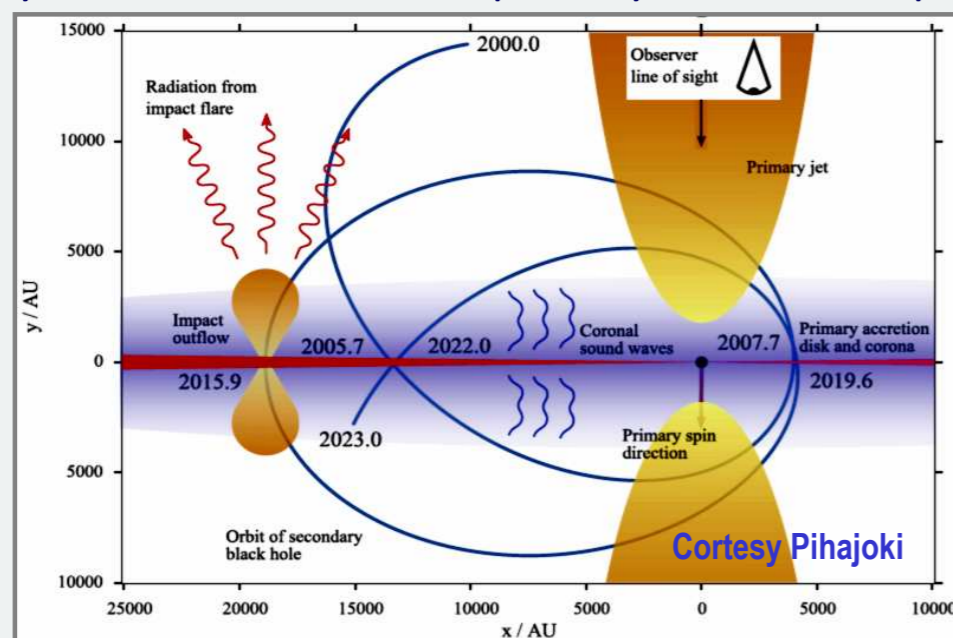
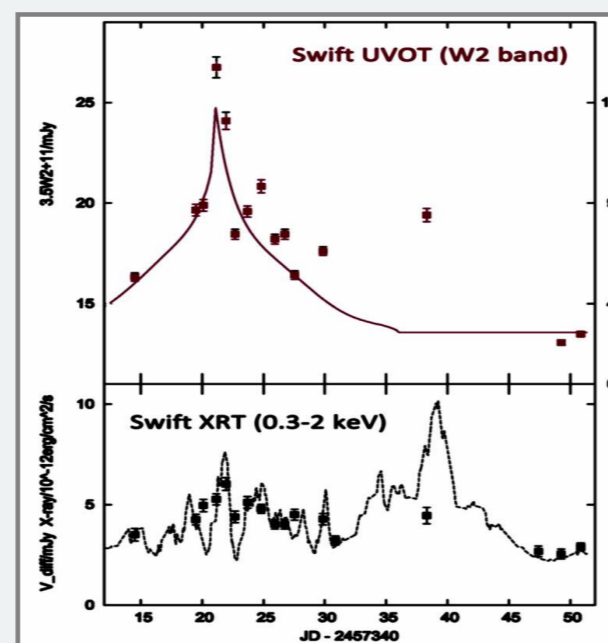
Introduction

Periodicity is a peculiar/controversial phenomenology claimed in radio/optical flux light curves of a few blazars. Significance estimates, red-noise, systematics, gaps in data gaps, makes results weaker than it is for X-ray binaries. BL Lac object OJ 287 (aka PG 0851+202, 3FGL J0854.8+2006, $z=0.305$) is a representative case study with both extended and intensive multi-frequency data.

The last optical and X-ray multi-frequency campaign

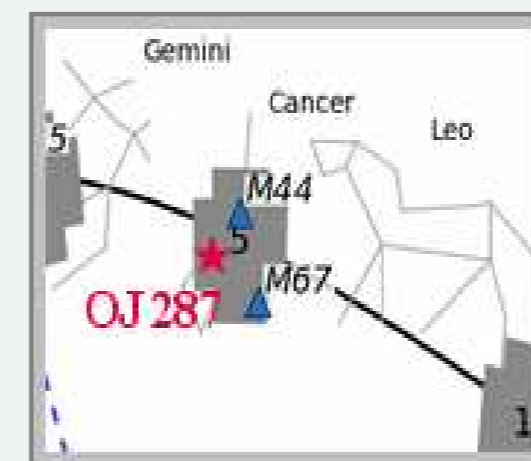
Swift time-domain experiment (monitoring) in Nov.2015-Jan 2016.

- Separation of disk impact/perturbation bremsstrahlung (binary SMBHs model) from synchrotron flares (erratic jet variability).
- X-ray emission coming from the jet. Orphan opt.-UV outburst → extra opt.-UV (non-jet) binary SMBHs perturbation emission.
- Post Newtonian approx. to General Relativity (GR, with massive BHs and strong-field) predictions are observed in optical data.
- Loss of orbital energy to gravitational radiation at 2% accuracy level. In future test BH no-hair theorem with 10% accuracy.
- Binary SMBHs masses: $1.5 \times 10^8 M_{\text{sun}}$, $1.8 \times 10^{10} M_{\text{sun}}$, orbital eccentricity 0.7. Evaluation of the primary Kerr SMBH spin (estimated primary SMBH Kerr parameter is 0.313 ± 0.01).

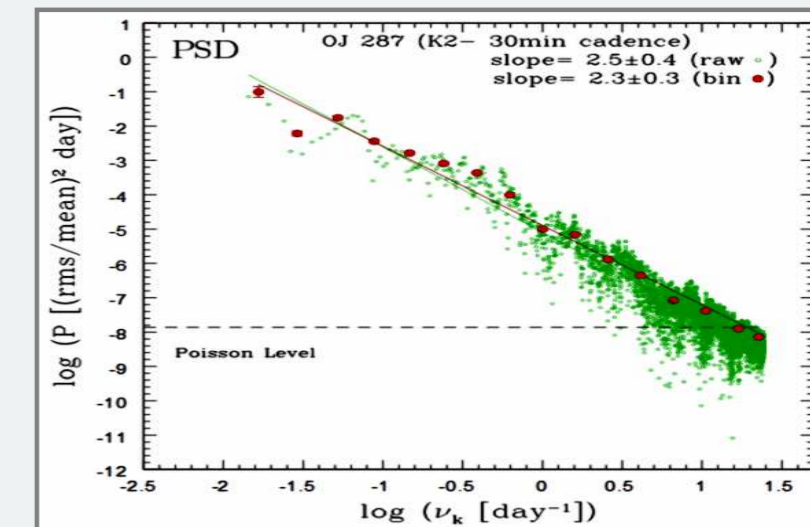
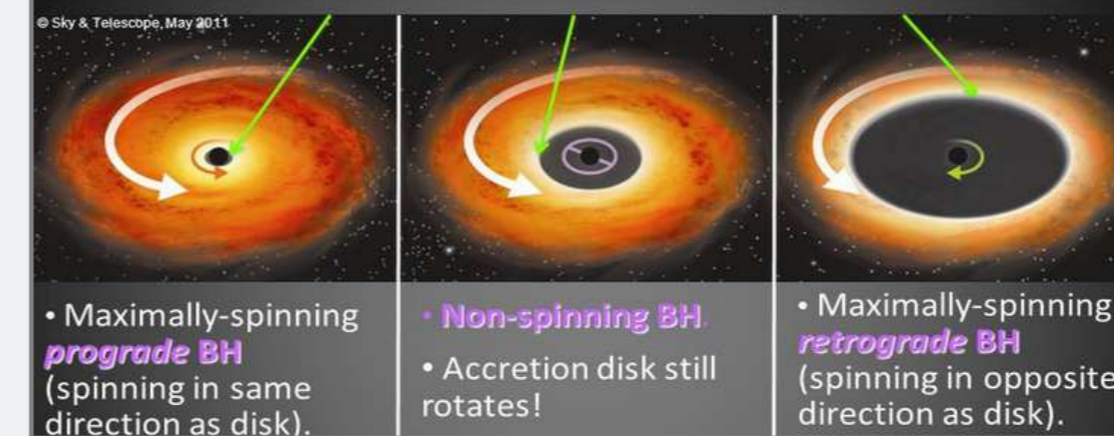


Conclusions: GR properties (masses, orbital param., no-hair theorem, precession, GW radiation losses) observed. Indirect evidence for binary SMBHs system. 10^8 - 10^9 years timescale from two galaxy merger to their central SMBH merger. OJ 287 sub-pc system: $<10^5$ years to merge. More tests of GR possible in next years (e.g., predicted 2019 optical outburst).

Kepler data



The Innermost Stable Circular Orbit



Intensive three-month campaign with 1 minute sampling with Kepler at >90% duty cycle and high S/N (K2 Campaign #5, Apr.27-Jul.13 2015). Swift almost daily simultaneous monitoring. No statistically significant periodicities detected in range from minutes to 30 days. ISCO QPOs in secondary jet (order of 1 day) not detected.

References

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