LT_supermassive_BH_zusammenfassung

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The identification and measurement of Lense–Thirring (LT) precession in AT2020ocn proceeds in two main stages:

1. **Timing analysis to detect the quasi-periodic modulation**
   - **High-cadence X-ray monitoring** with NICER (0.3–1.0 keV) provided a densely sampled light curve over the first 130 days after disruption.
   - A **Lomb–Scargle periodogram** (LSP) of the background-subtracted count rate was computed, revealing a broad peak at a period of $17^{+1.2}_{-2.4}$ days (identified visually as a 15-day quasi-periodicity) with harmonics at integer multiples .
   - To quantify the **statistical significance** of this feature, extensive **Monte Carlo simulations** were performed:
     1. Synthetic light curves were generated under various noise models (white noise, simple red-noise power laws, and bending power laws) matching the observed sampling.
     2. For each simulated dataset, the LSP was computed and searched for broad features of coherence $Q \in [2, 10]$, quantifying their total power.
     3. The distribution of the strongest simulated features was compared to the observed peak power.
   - The resulting **global false alarm probability** (FAP) of finding a peak as strong as the one at 15 days by chance was found to be $< 10^{-4}$, i.e. $> 3.9\sigma$ for all noise continua considered .

2. **Interpretation as LT precession and spin inference**
   - In the standard rigid-body LT precession model for a thick, misaligned disk [1, 2], the precession period t_p depends inversely on the dimensionless spin a, and scales roughly as

     $$t_p \simeq \frac{\pi}{a} \left(\frac{R_{\rm out}}{R_g}\right)^3 \frac{GM}{c^3} \times \xi(R_{\rm in}/R_{\rm out}),$$

     where $R_{\rm out}$ is taken as the circularization radius, $R_g = GM/c^2$, and ξ is a weak geometric factor .
   - Inverting this relation with the observed period ($15.9^{+1.1}_{-2.2}$ days) and adopting typical TDE parameters (solar-type star, impact parameter $\beta \simeq 2$, SMBH mass $\log M/M_\odot = 6.4 \pm 0.6$) yields a spin constraint

$$0.05 \lesssim |a| \lesssim 0.5\,.$$

- **Caveats & alternative models**:
  - Radiation-pressure instability can in principle produce 10–15 day cycles but requires fine-tuning of disk truncation and magnetic field strength to match the observed low amplitude.
  - Repeating partial TDEs or stream–stream collisions were found to be highly unlikely or to predict different timescales and amplitudes.
  - Disk-tearing into discrete rings can also precess at local LT rates, but again demands specific viscosity and thickness parameters to reproduce the 15 day period.

Overall certainty

- The detection of a robust, $> 3.9\sigma$ quasi-periodic signal in the X-rays is extremely unlikely to be a statistical fluke.
- The LT precession interpretation naturally explains both the X-ray flux *and* temperature modulations on the same timescale, and the absence of corresponding optical–UV quasi-periodicity.
- However, because other physical mechanisms (e.g. radiation-pressure instability, disk tearing) cannot be *completely* ruled out without further detailed modeling, the assignment to LT precession remains the most straightforward but not yet unambiguous explanation.