Growing Black Holes: Tidal Disruption of Stars

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Giant-amplitude X-ray flares from the centers of optically *non-active* galaxies were discovered and followed-up with the observatories *ROSAT*, *XMM*, *Chandra* and *HST*. These events, representing the highest amplitudes of variability ever recorded among galaxies, are interpreted in terms of flares of stars tidally disrupted by supermassive black holes at the centers of these galaxies; a process long predicted by theory (e.g., Rees, 1988, Nature 333, 523).

Three major feeding mechanisms have been studied in the context of black hole growth: accretion, black hole - black hole mergers, and tidal capture/disruption of stars. While there is ample evidence that accretion is ongoing in active galaxies, observational evidence for the two other processes remained elusive for many years. Given the intense theoretical work on, and importance of, these latter two processes, it is of great interest to see whether such events do occur in nature, how frequent they are, and which properties they show (on black hole mergers, see accompanying poster on NGC 6240).

With *ROSAT* several X-ray flares (e.g., Komossa & Bade 1999) from the directions of *optically inactive* galaxies (e.g., Gezari et al. 2003) were discovered, reaching quasar-like X-ray luminosities. Follow-up observations of RXJ1242-1119, the galaxy which flared most recently, revealed an amplitude of variability of a factor 1500 and we detected an \`afterglow´ of the flare located at the *center* of the galaxy (Komossa et al. 2004, Komossa et al., in prep.). With *XMM*, we could measure for the first time a post-flare high-energy spectrum in form of an unabsorbed powerlaw. Further flaring galaxies followed up with *Chandra* (Halpern et al. 2004) varied similarly strongly, by factors of 1000 (NGC 5905) and 6000 (RXJ1624+75). Such dramatic variability has never been observed before from galaxies. With the wealth of new data we now have excellent evidence that these events represent flares from stars tidally disrupted by supermassive black holes at the centers of the flaring galaxies.

These observations, and the presently ongoing search for new flares, are of great relevance in the context of black hole growth and galaxy evolution. In the future, flare studies may also open up a new window to study the general relativistic effects of precession of the stellar debris in the Kerr metric. They may also provide us with a new diagnostic of the circum-nuclear medium of these galaxies, since the bright flares will excite line-emission in surrounding gas .

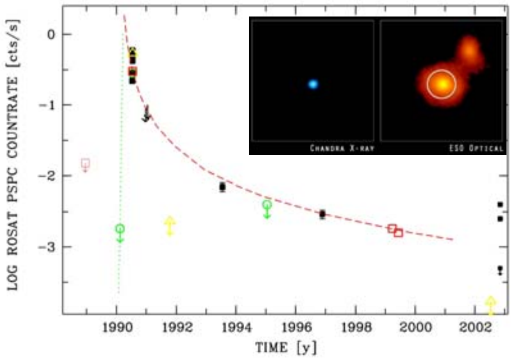

Fig. 1: Artist‘s sketch of the disruption and subsequent accretion of a star by a supermassive black hole. The accretion of the stellar debris causes a luminous flare of electromagnetic radiation. *Fig. 2*: Joint X-ray lightcurve of all flare events (shifted to the same t_{max}). The inset shows the optical image of RXJ1242-1119 which is in a pair (right) and *Chandra* detection of the ´afterglow´ emission of the once bright flare (left).

References:
- Gezari S., Halpern J., Komossa S., et al. 2003, ApJ 592, 42
- Komossa S., Halpern J., Hasinger G., et al. 2004, ApJ 603, L17
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