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Accretion Disk Instabilities and the Quasar Luminosity Function

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Abstract.
We predict the quasar luminosity function (LF) from a population of sources with the activity driven by instabilities in an accretion disk. The ligth curve of a single source convolved with the mass distribution gives the quasar luminosity function at a given redshift. We model the observed LF at four different redshifts.

Cavaliere & Padovani (1988, Ap.J. 333,L33) proposed three scenarios to explain the observed LF: long-lived objects, recurrent objects related to mergers and a single short event in the host galaxy life-time. None of these are closely related to the physical processes responsible for powering a quasar. Here we propose a scenario which for the first time binds the activity and the luminosity functions together.

We have studied the evolution of an accretion disk around a supermassive black hole (main components of the quasar paradigm), on long timescales due to thermal-viscous instabilities (Siemiginowska et al. 1996, Ap.J.,458, 491 and references therein). Depending on the assumed disk model, large amplitude variations ($\Delta \log L \sim 4$) can be seen in a light curve of one source on timescales of $10^3 - 10^6$ years (Fig 1). We assumed that quasars are subject to such variability. The light curve of a single source convolved with the mass function gives the LF at a given redshift. The mass function can be derived from the cosmology (Press & Schechter, 1974, Ap.J. 187,425). Here we assumed that it has a form of the 4th order polynomial, where polynomial coefficients are unknown parameters in the calculations. Standard χ^2 method was used in the fitting procedure.

We model the observed LF (Boyle et al 1991, in ASP Conf.Series Vol. 21, p.191) at four redshift bins. The results are presented in the Fig.2. The derived luminosity function contains a break similar to the break in the observed LF. Since the required accretion rate is low, the remnant sources do not grow to the massive black holes. A $10^8 M_\odot$ black hole will increase its mass 3 times over 10^9 years. Fitting the observed LF gives the mass distribution at a given redshift and the evolution of the mass function which are presented in Siemiginowska 1996 (in preparation).

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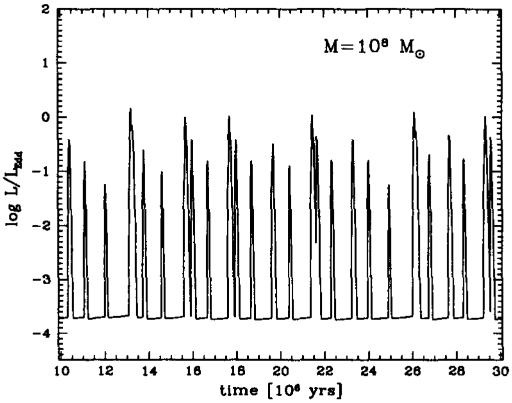

Figure 1. Luminosity variations due to the disk instabilities around a black hole of $10^8 M_{\odot}$, when the accretion rate is 0.01 $M_{\odot}$ yr^{-1} and the viscosity parameter is different in the high and low luminosity states: $\alpha_{hot} = 0.1$ and $\alpha_{cold} = 0.025$.

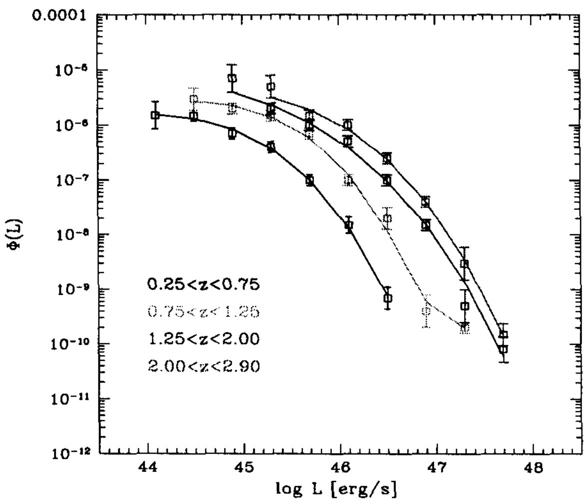

Figure 2. Observed LF (Boyle et al 1991) at four redshifts (points with error bars). The model fit is plotted with the solid line

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