

# Intermittent activity of radio sources. Accretion instabilities and jet precession.

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**Abstract.** We consider the radiation pressure instability operating on short timescales ( $10^3 - 10^6$  years) in the accretion disk around a supermassive black hole as the origin of the intermittent activity of radio sources. We test whether this instability can be responsible for short ages ( $< 10^4$  years) of Compact Steep Spectrum sources measured by hot spots propagation velocities in VLBI observations and statistical overabundance of Gigahertz Peaked Spectrum sources. The implied timescales are consistent with the observed ages of the sources. We also discuss possible implications of the intermittent activity on the complex morphology of radio sources, such as the quasar 1045+352, dominated by a knotty jet showing several bends. It is possible that we are witnessing an ongoing jet precession in this source due to internal instabilities within the jet flow.

**Keywords.** physical data and processes: accretion, galaxies: evolution, quasars: individual (1045+352)

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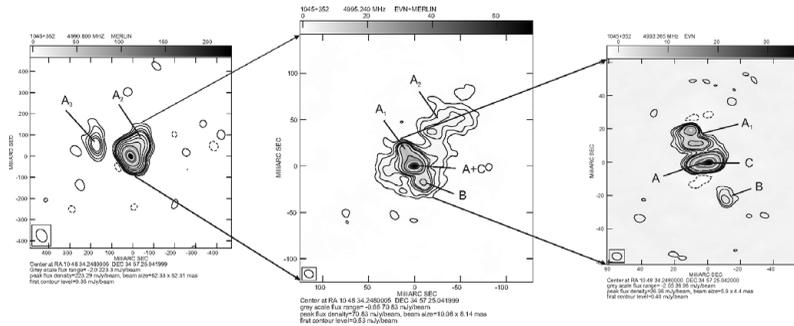
## 1. Introduction

The compact radio sources consist of two population of objects: the gigahertz-peaked spectrum (GPS) and compact steep spectrum (CSS) sources which are considered to be young and evolve into large radio objects, during their lifetimes (O’Dea, 1998). However, it has already been pointed out by some authors (Gugliucci *et al.* 2005, Kunert-Bajraszewska *et al.* 2006) that there exists a group of GPS/CSS sources that will never evolve to become large scale objects, at least in a given cycle of activity if it is recurrent. These sources can be named short-lived radio objects.

We associated the existence of short-lived compact radio sources with the intermittent activity of the central engine caused by a radiation pressure instability within an accretion disk, which we briefly mention below.

## 2. Discussion and Results

According to the accretion disk instability model, for a given black hole mass, the larger the mean accretion rate, the longer the duration of a cycle episode, both in hot and cold states. In addition the viscosity parameter affects the results and for smaller viscosity, the cycle duration is longer. This relation was calibrated by Czerny *et al.* (2009) using a grid of models for various black hole masses and Eddington ratios. The outbursts are associated with the ejections of radio jets. The jets are then turned-off between the outbursts and each radio structure will represent a new outburst. In case of an apparently young, compact source we can suspect that in fact it is an old, reactivated object, in which



**Figure 1.** Radio images of 1045+352 at 5 GHz made with (from left): MERLIN, EVN+MERLIN, EVN. Contours increase by a factor 2 and the first contour level corresponds to  $3\sigma$ . Indications: C - radio core, A-A<sub>3</sub> - radio jet, B - probable counter-jet.

the vast radio structures have already faded away and are not visible. We have applied i.a. the accretion disk instability model and jet precession model to explain the potential reactivation of the 1045+352 core (Kunert-Bajraszewska *et al.* 2010).

1045+352 is a CSS object and a HiBAL quasar at a medium redshift. Its linear size ( $\sim 4$  kpc) indicate it is a young object in the early phase of quasar evolution. The radio morphology of 1045+352 is dominated by the strong radio jet resolved into many sub-components and changing the orientation during propagation in the central regions of the host galaxy. As a consequence we observe at least three phases of jet activity indicate different directions of the jet outflow: components A<sub>2</sub>-A<sub>3</sub> as the oldest one, structure A<sub>1</sub>-B as the younger one, and the jet A as the current activity direction (Fig.1).

The results of the applied accretion disk instability model (Janiuk *et al.* 2002, Czerny *et al.* 2009) is not in agreement with the 1045+352 structure and size: (a) the calculated duration of the activity phase of the quasar is too short to enable the source grow to the observed size, (b) it cannot reproduce misalignment between the young and old radio structures. Such misalignment could be the result of the changed direction of the jet axis between the activity episodes - precession. In the case of 1045+352 we considered the precession of the innermost accretion disk due to internal instabilities within the accretion flow (Janiuk *et al.* 2008). This precession model reproduced well the observed complex structure of 1045+352. However, as discussed by Czerny *et al.* (2009), the mechanism of the accretion disk instability can be considered as the one that could explain the apparent statistical excess of the compact radio sources with respect to the galaxies with extended radio structures.

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