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Long-Term Variability of AGN

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Abstract. We present a long-term variability study of the Seyfert 1 galaxies Mkn 110 and NGC 7603. Both objects show strong variations over a period of several years.

1. Introduction

For more than ten years, we have been obtaining spectra of selected Seyfert galaxies in order to study their long-term variations. We use variability analysis as a tool to determine the physical properties of the broad-line region (BLR) in AGN, such as size, structure, and kinematics.

Observations were performed at Calar Alto in Spain and at ESO in Chile with sampling rates of weeks to years. We selected Seyfert galaxies with disturbed morphology to investigate a possible relationship between gravitational interaction of galaxies and variability properties.

The concept that nuclear activity in Seyfert galaxies and quasars is triggered by gravitational interactions with the environment of AGN has received much observational and theoretical support (reviewed by Fricke & Kollatschny 1989). Our galaxies show disturbed morphologies and tidal arms as signatures of former gravitational interaction. According to the above concept these objects are in an early epoch of their activity.

2. Spectra and Light Curves

Figure 1 shows spectra of Mkn 110 at different epochs. Strong variations of the continuum and the broad emission lines over a period of several years are obvious. Most striking are the variations of the helium lines.

We created light curves of the continuum flux, the Balmer lines Hα, Hβ, and Hγ, and the helium lines He I λ5876, He I λ4471, and He II λ4686. These light curves cover periods from 1987 to 1992 (Mkn 110) and from 1974 to 1992 (NGC 7603). Variations were found for all broad lines during the whole period of observations. The amplitudes $R_{max} = I_{max}/I_{min}$ of different light curves range from 2 to 10. R_{max} increases for the sequence Balmer lines, He I, and He II, as a

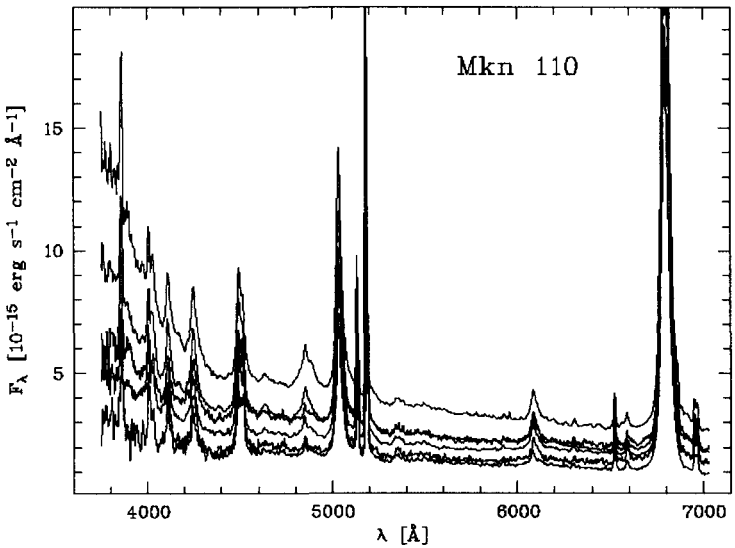

Figure 1. Optical spectra of Mkn 110 from 1988 Oct., 1989 Oct., 1988 Mar., 1989 Feb., 1987 Feb., and 1990 May (from bottom to top).

function of excitation energy. The strongest amplitude was found for He II λ4686 in Mkn 110.

Strong variations were found in the spectra during the whole period of observations. Due to the moderate sampling rate of our observations, cross-correlation techniques are suitable only to estimate upper limits. From the FWZI of the autocorrelation function (compared to the sampling window) we infer an upper limit of about 100 light days for the outer radius of the broad emission-line region of Mkn 110 and a even larger radius for NGC 7603. This is comparable to other objects of the same luminosity (cf. Carone et al. 1996).

From difference spectra we detected subcomponents in the Balmer emission lines. This indicates that the BLR is structured; different line components originate in different parts of the BLR. Comparing the variations of blue and red line wings simple velocity fields, such as radial inflow or outflow and pure rotational motions, can be ruled out. The Balmer decrement Hα/Hβ decreases with increasing Balmer-line flux. This may be caused by radiation transport effects in the BLR.

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References

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