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Ultraviolet variability in the nucleus of the elliptical galaxy NGC 4278

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Abstract. We searched the HST Science Archive for the nuclei of elliptical galaxies with images obtained in different epochs, to detect the presence of far-ultraviolet variability. We found multi-epochs observations only for the elliptical galaxy NGC 4278. It hosts a barely resolved nuclear source which increased its UV flux by a factor 4 between June 1994 and January 1995. The properties of the UV flare of NGC 4278 are remarkably similar to the UV-bright nuclear transients discovered earlier in other low-luminosity AGNs. This supports the idea that UV flaring near the center of galaxies may be a common event and offers a way to search for black-hole-related activities in otherwise quiescent galaxies.

Key words. black hole physics, galaxies: elliptical and lenticular, cD, galaxies: nuclei

1. Introduction

Although Active Galactic Nuclei (AGNs) represent a small fraction of the total number of extragalactic sources, there is evidence that a low nuclear activity is a common feature among galaxies. A large fraction of galaxies are characterized by the presence in their nuclei of low-ionization nuclear emission line regions (LINERs, Ho et al. 1997). They are a class of objects grouped under the name of Low-Luminosity Active Galactic Nuclei (LLAGNs). LINER nuclei may be the manifestation of a central supermassive black hole (SBH), however it is still not clear if the compact UV nuclear sources present in many LINERs is directly connected to the accretion process.

The serendipitous discovery of an ultraviolet flare in the nucleus of the elliptical galaxy NGC 4552 (Renzini et al. 1995), suggested that flaring near the center of galaxies may be a common event and offers a way to search for SBH-related activities in otherwise quiescent galaxies. It has been suggested that a central ultraviolet-bright flare is the result of the tidal disruption (or stripping) of a star in a close fly-by with the SBH (Renzini et al. 1995; Gezari et al. 2006). Cappellari et al. (1999) found a transient accretion event onto its central SBH by improving the observation of the same galaxy. They concluded that NGC 4552 could be considered as a mini-AGN. Maoz et al. (2005) monitored the UV variability for a sample of 17 galaxies with LINER nuclei and compact nuclear UV sources. They analyzed images obtained with the Advanced Camera for Surveys (ACS) on board the Hubble Space

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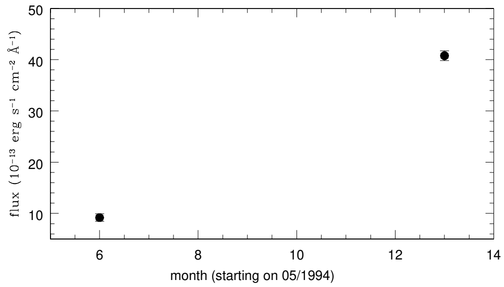

Fig. 1. UV light curve in F218W for the nucleus of NGC 4278. Points correspond to the image taken on June 1994 and January 1995.

Telescope (HST). They found significant UV variability in most of the sample galaxies and suggested that this is a common phenomenon providing the missing link between LINER emission and AGNs.

2. Data acquisition

We were interested in finding other cases of UV variability in the nuclei of elliptical galaxies. We looked in the HST Science Archive for UV images taken with the Wide Field Planetary Camera 2 (WFPC2) and ACS for all the 1300 elliptical galaxies listed in RC3. We found images for 38 galaxies. Three images in two different epochs with the same filter were available only for NGC 4278. These were acquired with the WFPC2/F218W filter. The galaxy nucleus was imaged by the Planetary Camera chip, which has 800×800 pixels operating at 0.046"/pixel scale. The first image was acquired on 02 June 1994, the other two on 14 January 1995.

3. Data analisys

Standar data reduction were automatically performed by the Space Telescope Science Institute pipeline, except for cosmic-ray rejection. In order to remove cosmic rays we used the LACOS_IMA procedure.After being combined the two images of January 1995 as well as that of June 1994 were normalized to 1 second of exposure time to allow the comparison of the nuclear activity. We carried out aperture photometry of the nuclear source in the two images. It is barely resolved (FWHM=1.56 pixel) when compared to the WFPC2/F218W PSF (FWHM=1.31 pixel) derived with the TINYTIM task.To estimate the total flux of the central UV source we summed the counts in a circle, centered on the source, with radius of 6 pixel. The background level was determined as the median of the counts within an annulus at radii of 8-11 pixel. Counts were converted to flux densities using the conversion given by the PHOTFLAM keyword (1 e^{-} s^{-1} = 1.072×10^{-15} ergs cm^{-2} s^{-1} Å^{-1}) in the image headers. Errors were calculated by combining in quadrature the Poisson errors and the readout noise errors for the pixels within the aperture. We found the UV flux of the central source of NGC 4278 rose from 9×10^{-13} to 4×10^{-12} ergs cm^{-2} s^{-1} Å^{-1} from June 1994 to January 1995 (Fig. 1).

4. Results

Using the WFPC2/F218W images of different epochs available in the HST Science Archive we detected a far-ultraviolet nuclear activity in the elliptical galaxy NGC 4278. The source increased its UV flux by a factor 4 in about 6 months. The source is almost certainly associated to the low-luminosity AGN responsible for the radio emission of NGC 4278 (Giroletti et al. 2005). The properties of the UV flare are remarkably similar to the UV-bright nuclear transient discovered earlier in NGC 4552 (Renzini et al. 1995; Cappellari et al. 1999) and NGC 1399 (O' Connell et al. 2005). This finding supports the idea that UV variability is a common phenomenon in low-luminosity AGNs as suggested by Maoz et al. (2005).

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