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Testing the Standard Model of Active Galactic Nuclei through Quasar Variability

Alessandro Ederoclite[1,2], Jana Polednikova[1,2], Jordi Cepa[1,2], José Antonio de Diego Onsurbe[1,3], and Ignacio González-Serrano[4]

[1]Instituto de Astrofísica de Canarias, La Laguna, Tenerife, Spain
[2]Departamento de Astronomía, Universidad de La Laguna, Spain
[3]Instituto de Astronomía, Universidad Nacional Autonoma de México
[4]Instituto de Física de Cantabria (CSIC- Universidad de Cantabria), Santander, Spain

Abstract. The standard model of Active Galactic Nuclei (AGNs) predicts that Type 2 AGNs and Type 1 AGNs only differ in the orientation of a dust torus, which does or does not allow one to observe the central region. If the model is correct, the time-scales and the amplitudes of observed temporal variations should be different between obscured and unobscured objects. In order to test this hypothesis, we started a multi-wavelength ($BRIJK_s$) monitoring campaign of a sample of quasars of both types. Here we present the data and preliminary results of that project.

Keywords. quasars: general

1. Introduction

The main idea behind the AGN Standard Model is that the AGN type depends on the inclination of a torus of dust with respect to the line of sight, thus allowing (or not allowing) one to observe directly the accretion on a supermassive black hole. Non-obscured AGNs have typically been identified as showing wide permitted lines as well as narrow permitted and forbidden lines. These objects are usually referred to as Type 1 AGNs. On the other hand, obscured AGNs only show narrow permitted and forbidden lines; they are referred to as Type 2 AGNs. Nevertheless, there are some features of the Type 2 quasars which do not completely fit the unified model, such as the large fraction of moderate radio emitters with a flat spectrum respect to Type 1 quasars (Vir & Ho 2010).

Assuming that the standard model is correct, we would then expect that Type 1 quasars have higher variability, and on shorter time-scales, than Type 2 quasars. Variability in Type 2 quasars could be justified on the assumption of a clumpy torus. If such variability were observed in Type 2 quasars, it would put strong constraints on the structure of the torus. However, since such a systematic study is missing, we took on the challenge to prove the AGN Unified Model by looking for variability in quasars.

2. The Quasar Sample

We selected 5 Type 2 quasars and 5 Type 1 ones of similar brightness, in order to be able to observe them all with a small telescope. Our targets are listed in Table 1. The Type 2 quasars were extracted from the Sloan Digital Sky Survey (Zakamska *et al.* 2003, 2004). The Type 1 quasars were selected from the the 2dF survey (Croom *et al.* 2001, 2004, 2006). Since the main selection criterion is apparent brightness, the Type 1 quasars have a comparatively higher redshift than the Type 2 ones.

Name	RA.	Dec.	mag. (filter)	z
J1045+0046	10:45:34.30	+00:46:17.0	19.558 (g)	1.26
J1211+0049	12:11:18.50	+00:49:25.0	19.88 (V)	1.47
J1334-0120	13:34:11.10	−01:20:53.0	19.68 (V)	1.620
J1449-0120	14:49:48.10	−01:20:42.0	19.76 (B)	0.97
J1402+0026	14:02:50.60	+00:26:07.0	19.95 (B)	0.857
SDSSJ1133+61	11:33:44.02	+61:34:55.7	19.03 (r)	0.426
SDSSJ1157+6003	11:57:18.35	+60:03:45.6	19.48 (r)	0.49
SDSSJ1337-0128	13:37:35.02	−01:28:15.7	18.60 (r)	0.329
SDSSJ1430-0056	14:30:27.66	−00:56:14.9	18.99 (r)	0.318
SDSSJ1501+5455	15:01:17.96	+54:55:18.3	18.57 (r)	0.339

Table 1. Quasars studied for weekly variability. The first five are Type 1 quasars; the second five are Type 2.

Name	RA.	Dec.	g-mag	z
SDSSJ0759+5050	07:59:40.96	+50:50:24.9	16.54	0.054
SDSSJ1430+1339	14:30:29.89	+13:39:12.1	16.75	0.085
SDSSJ1440+5030	14:40:38.10	+53:30:15.9	15.60	0.037

Table 2. Type 2 quasars analyzed for micro-variability.

In order to analyze micro-variability, we included the brightest Type 2 quasars from Reyes *et al.* (2008) and which we list in Table 2. In this case too, the main driver of the target selection was the brightness ($g < 17$), since we wanted to be able to access the objects with the 1.5-m telescope at San Pedro Mártir Observatory. The target sample will be complemented with the sample of Type 1 quasars studied by de Diego *et al.* (1998) and by Ramírez *et al.* (2009).

3. The Observations

Observations of variability on a time-scale of weeks were carried out in BRI with the 80-cm IAC-80 telescope, and in JK_s with the 1.5-m Telescopio Carlos Sanchez (TCS) at Teide Observatory, Tenerife. Taking advantage of service-mode observing, we obtained observations spread over about three months per target. The fields are comparatively sparse, but the relatively large field of view ($\sim 10' \times 10'$) of the camera on the IAC-80 enabled us to identify a number of good comparison stars for differential photometry. (Since our goal was to look for variability only, we did not observe standard stars). The field of view of the near infra-red camera on the TCS is significantly smaller than that of the IAC-80, so we had fewer comparison stars. Those data will be calibrated with stars from 2MASS.

Micro-variability observations were carried out in BVR with the 1.5-m telescope from San Pedro Mártir Observatory during four nights in visitor mode. Individual exposures were 60 seconds, and each quasar was followed for two to four hours.

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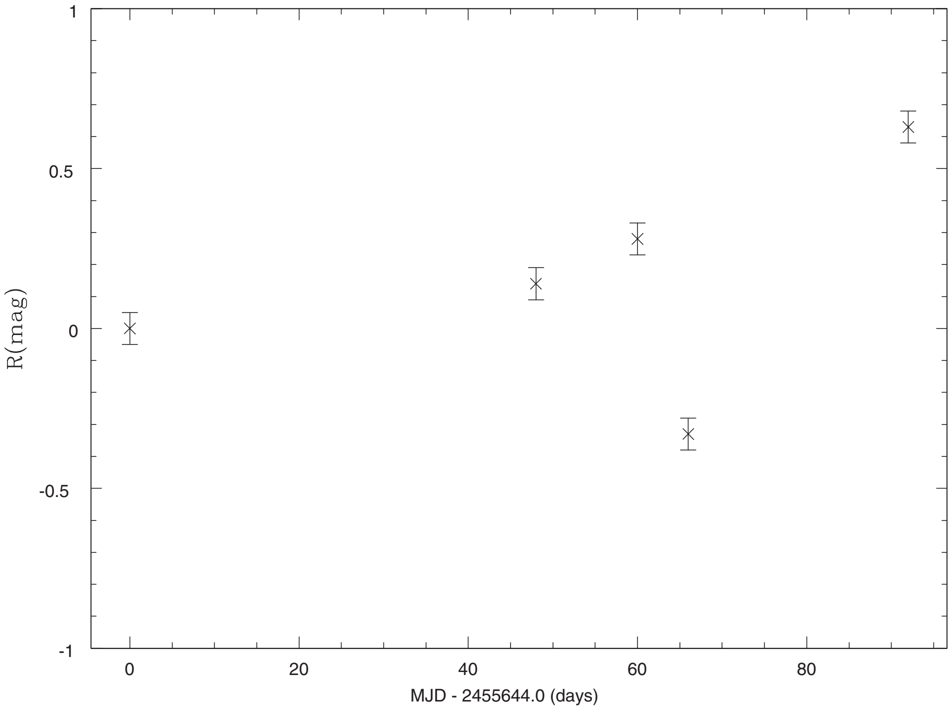

Figure 1. Preliminary R-band light curve of J1334-0120, in days from the beginning of the campaign. The magnitudes are relative to the magnitude of the object during our first observation.

4. Summary and Perspectives

During a pilot programme of a project to test the AGN unification model through quasar variability, we have obtained about three months of observations for ten quasars (5 of Type 1 and 5 of Type 2) in $BRIJK_s$ bands, and four nights of micro-variability (in BVR) for 3 Type 2 quasars (a control sample of Type 1 quasars is already available).

The analysis is under way (see Fig. 1). An extension of the programme to fainter and to more objects is foreseen in order to increase the statistical significance of the results, and to probe a larger volume of Universe. The results of our pilot programme will allow us to choose the best strategy and target selection methods for campaigns on larger (2-m to 10-m) telescopes.

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