

Light Curves of Lensed Components and Time Delay Measurements in the Binary Gravitationally Lensed Quasars SDSS J2124+1632 and SDSS J0806+2006

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Abstract—The article presents the results of long-term photometric monitoring of two binary gravitationally lensed quasars, SDSS J2124+1632 and SDSS J0806+2006, carried out at the Maidanak Observatory in 2017–2022. The obtained light curves of the lensed components of both systems are analyzed. The variability of SDSS J2124+1632 turned out to be quite large: up to 0^m50 for the system as a whole and up to 0^m75 for component A. Long-term microlensing was found against the background of a general increase in the apparent brightness of the quasar source. The brightness variations in SDSS J0806+2006 are less intense: the range is about 0^m20 for the system as a whole, and up to 0^m25 for both components. Analysis of the light curves did not show the presence of microlensing here. We also calculated the probable values of the time delay: $\Delta t_{AB} = 102 \pm 20$ days (component B is in the lead) and $\Delta t_{AB} = -53.0 \pm 6.0$ days (component A is in the lead) in SDSS J2124+1632 and SDSS J0806+2006, respectively. The value of Δt_{AB} for SDSS J2124+1632 is consistent with previously found time delays for binary gravitationally lensed systems. In the case of the second system, the time delay is consistent with earlier theoretical calculations, which suggested that the time delay should be about 50 days.

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1. INTRODUCTION

Currently, the study of gravitational lensing has become one of the powerful tools for solving astrophysical problems of various scales: from small regions around compact objects in our and other galaxies up to cosmological distances.

Gravitationally lensed quasars (GLQs) occupy a special place among a wide class of gravitationally lensed systems. Information about the configuration of lensed systems, time delays in them, microlensing and many other information allow us to study the fine substructure, mass distribution and evolution of lensing galaxies. For example, the time delay between lensed components is used to determine the Hubble constant, the most important cosmological parameter in determining the size, age, and critical density of the Universe (Reisdaal, 1964; Schneider et al., 1992). If we consider that there is a significant difference between the estimates of the Hubble constant from observations of objects in the early and late Universe, then its independent measurements on the example

of quasars with different redshifts become especially relevant (Verde et al., 2019).

In recent years, the number of new discovered GLQs in the GRAL, Gaia, SDSS, and other projects has been constantly increasing (Lemon et al., 2018, 2019, 2022; Stern et al., 2021; Chan et al., 2022). At the same time, the need for continuous monitoring observations of selected GLQs and photometric processing of these data increases in order to determine the time delay for the objects under study.

This article presents the results of photometric monitoring of the binary GLQs, SDSS J2124+1632 and SDSS J0806+2006, carried out in 2017–2022 at the Maidanak Observatory.

2. PRELIMINARY DATA

SDSS J2124+1632. The object was discovered relatively recently, as reported in the article by Lemon et al. (2018). The authors of the cited work spectroscopically confirmed 24 new lensed quasars discovered by the Gaia space observatory, and also calculated their preliminary characteristics.

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