# *Some results from an optical monitoring of four quasars at Calar Alto Observatory (Almería, Spain)*

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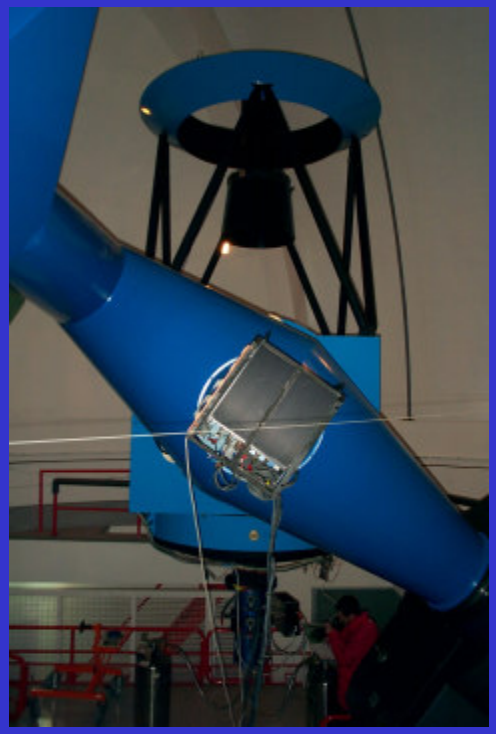
# INTRODUCTION

- We carried out an intensive monitoring in Calar Alto Observatory (Almería, Spain) between 2003 March 3 and 2003 June 2

- The scientific interest of our monitoring was to find and study the variability in four targets: two double quasars and two isolated ones

- Another interest for us was to test the capability of the EOCA telescope, in order to carry out future programs for gravitational lenses



Telescope: EOCA (1.52m), Calar Alto Observatory

Observer: Aurora Ullán

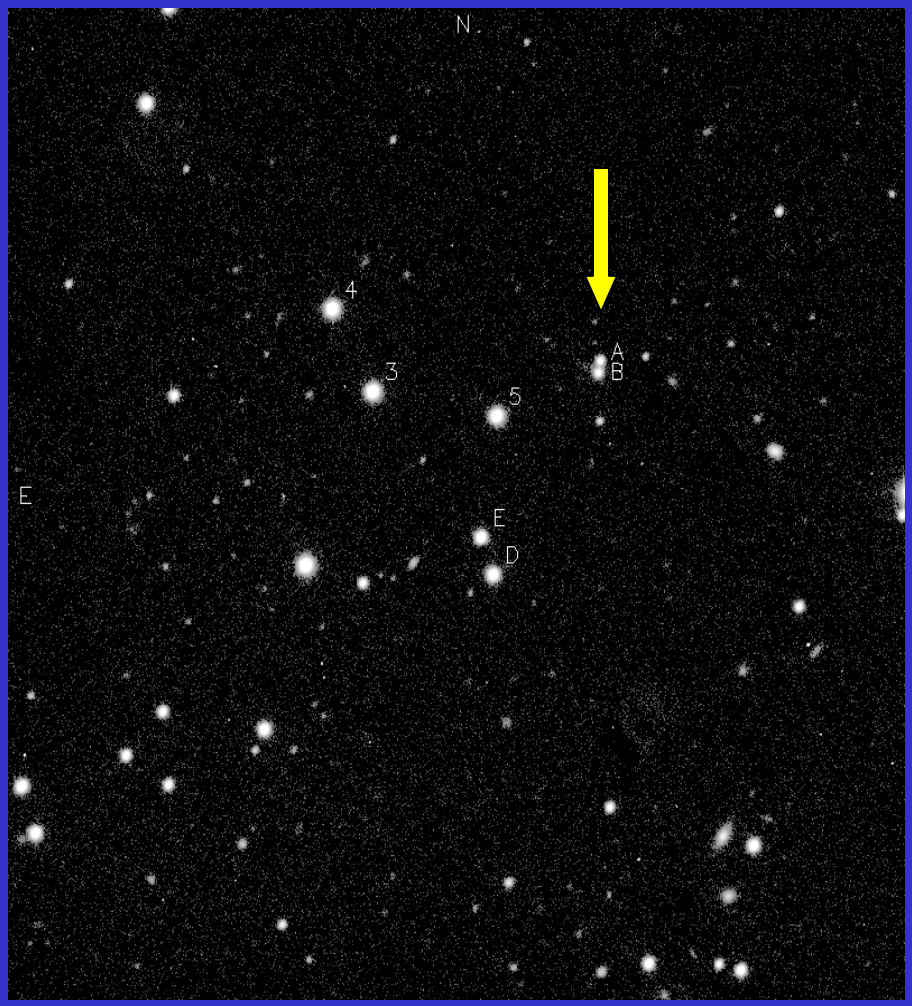
Data analysis: UC & Univ. Oslo

- We tried to take at least three different frames for each system and each night in order to obtain a “local” estimation of the errors

- A typical exposure is 300s in V and 150 in R (in general for all the targets)=> not very long in order to NOT saturate the reference stars

- We used always R and V Johnson filters

# The Double Quasar: QSO 0957+561 A,B




QSO 0957+561 A,B

- QSO 0957+561 was the first lensed quasar
- It was discovered in 1979 by Walsh et al.
- It is formed by two images (A and B) from an inner region of a far quasar ( z = 1.41 )
- The distance between A and B is 6.1”
- The main lens galaxy ( z = 0.36 ) is a giant elliptical one residing in a cluster of galaxies and was discovered by Stockton in 1980

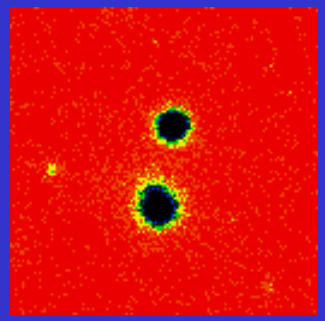
- TWO PHOTOMETRIC METHODS:

  - Jan-Erik -> PSF with an IDL task

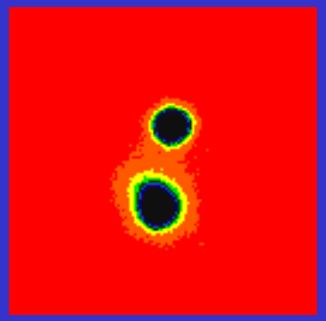
  - Aurora -> psfphot (PSF fitting)

* RESULTS : ALMOST THE SAME!!!

(1) REAL FRAME

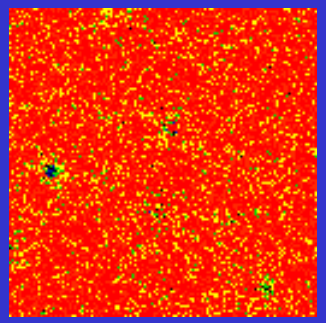


(2) MODEL

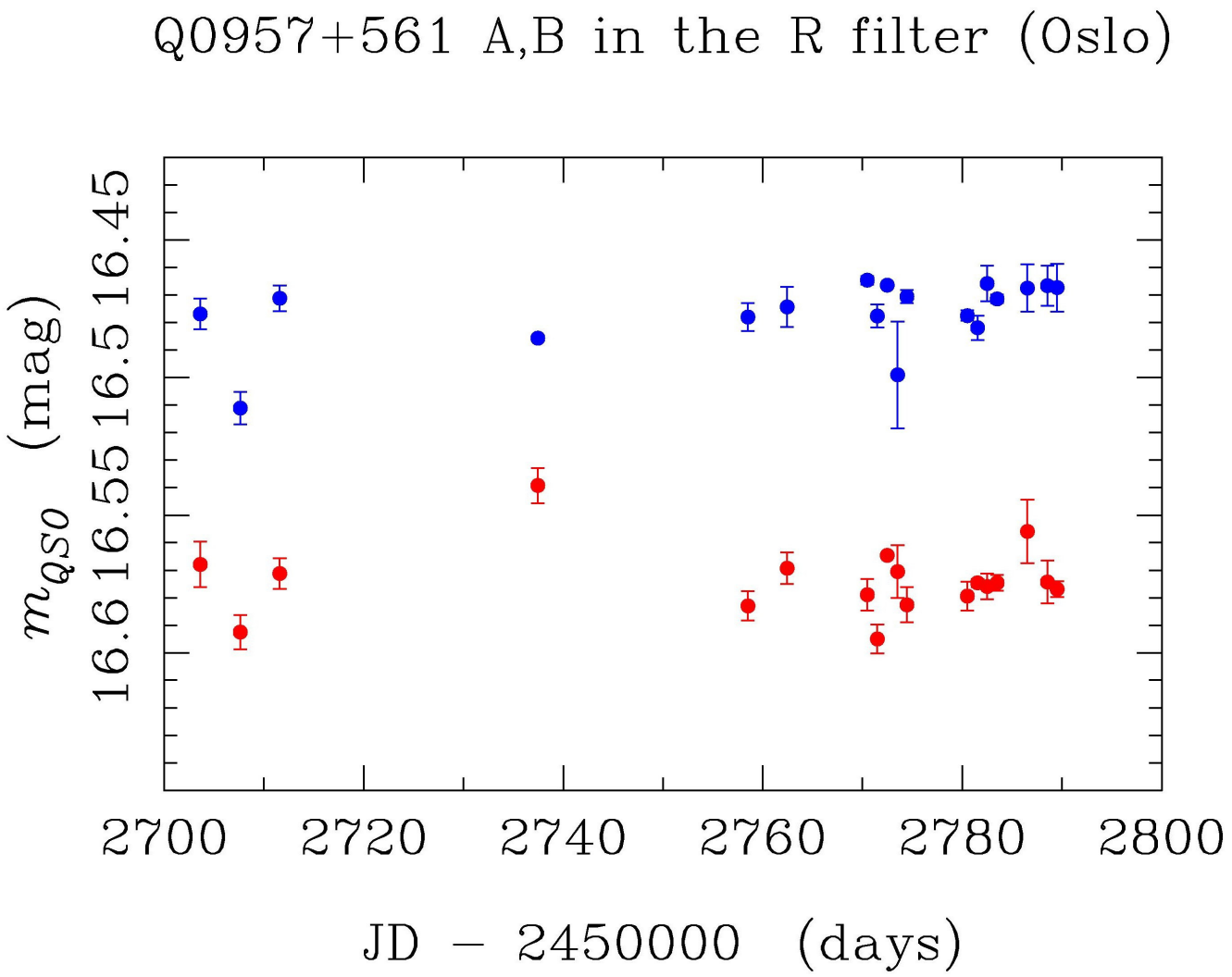


(1) – (2) = (3)

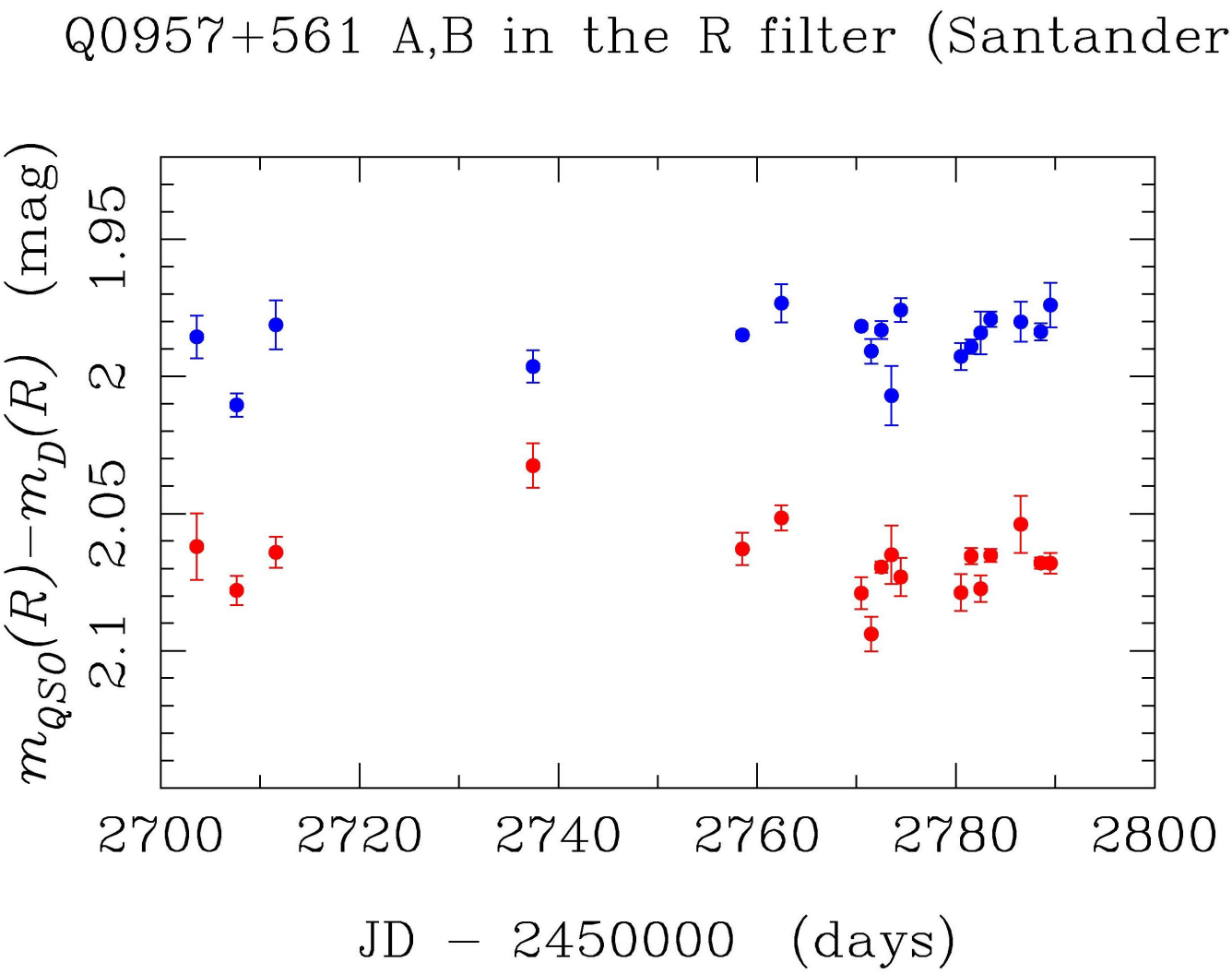
(3) RESIDUAL

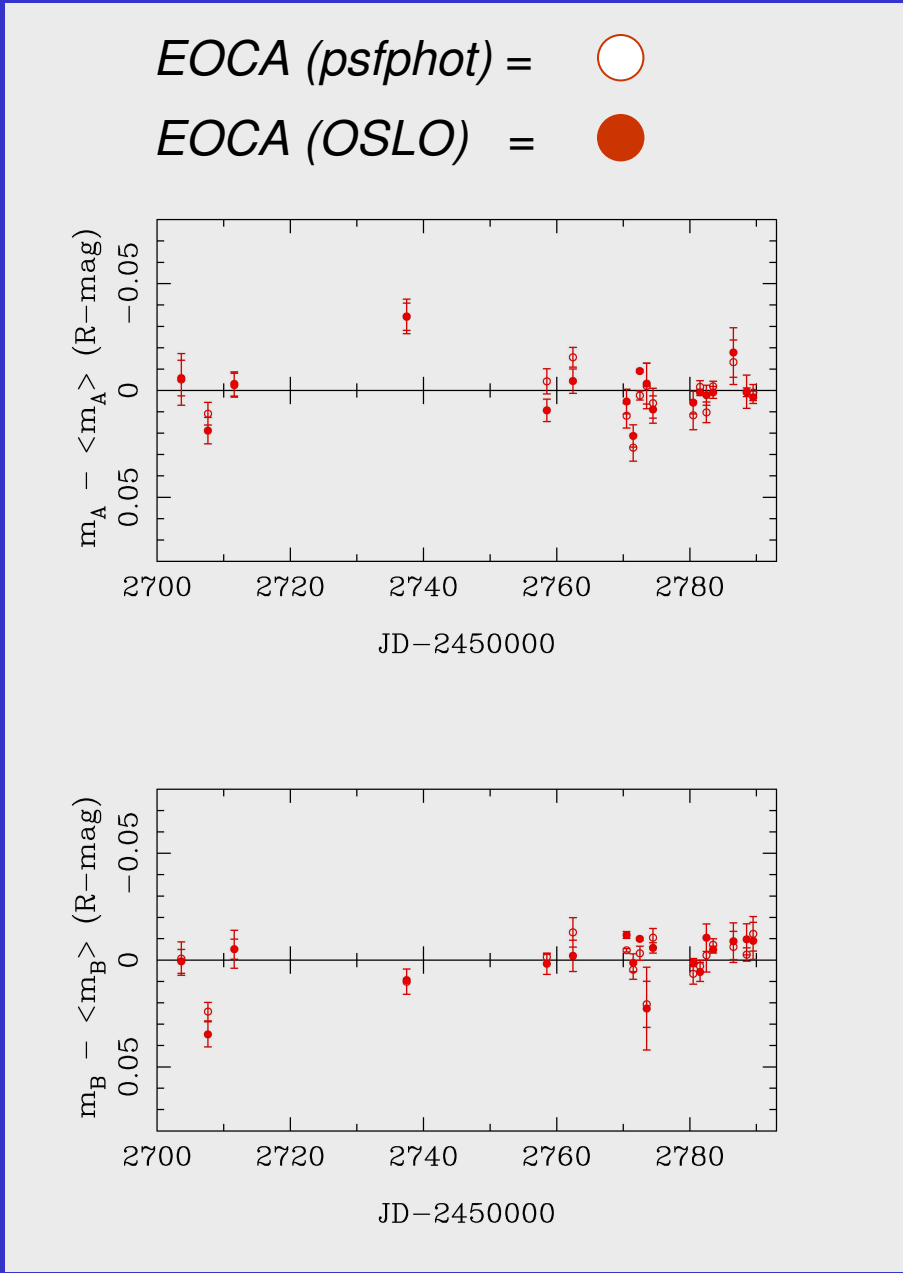


RED-> A COMPONENT BLUE-> B COMPONENT



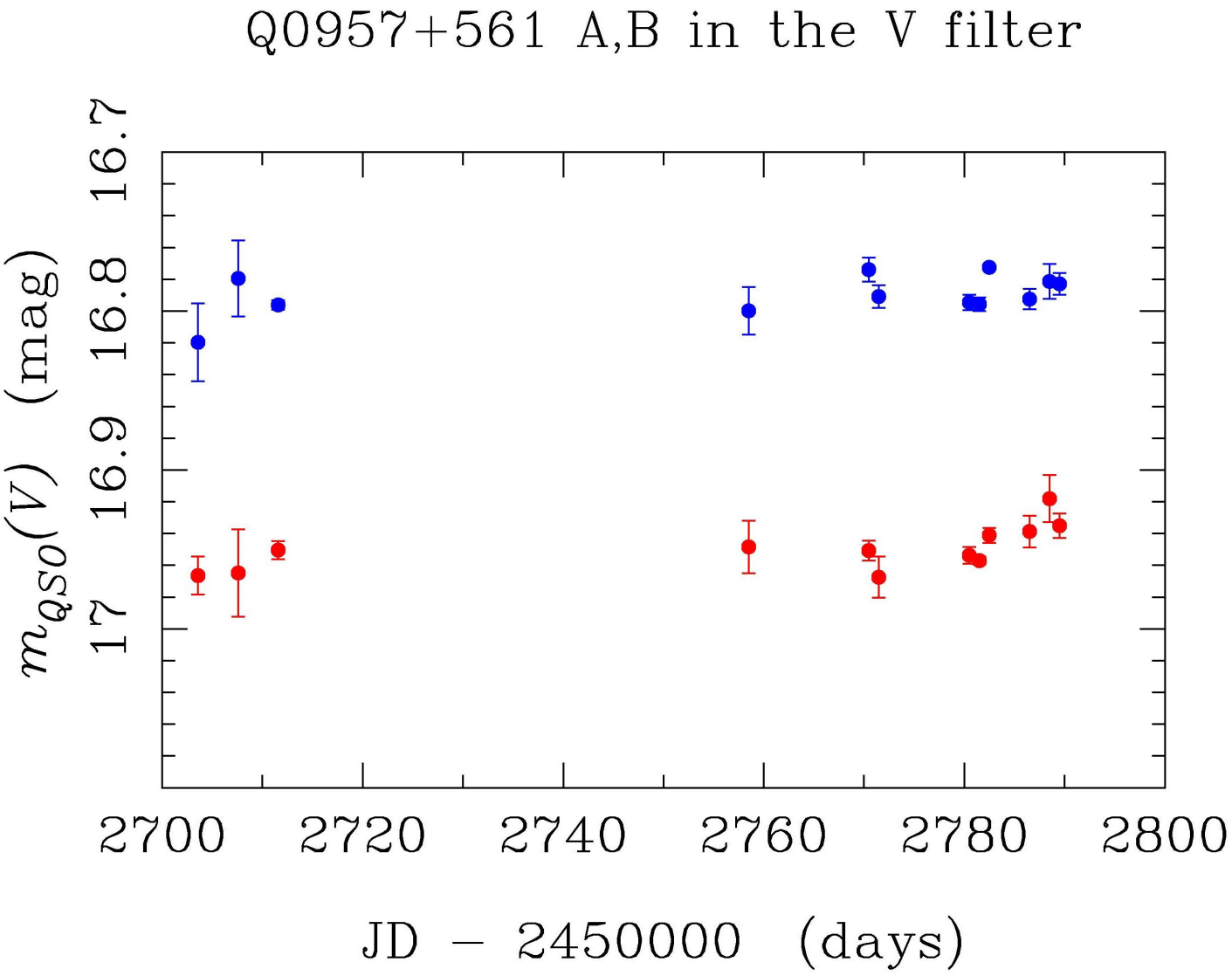
RED-> A COMPONENT BLUE-> B COMPONENT






- We compute the diference between each magnitude with the median magnitude for each component ( on each photometry)

- We see that the results are very similar....it should be ok!!


Q0957+561 A,B in the V filter
$m_{QSO}(V)$ (mag)
16.7
16.8
16.9
17
2700
2720
2740
2760
2780
2800
JD − 2450000 (days)

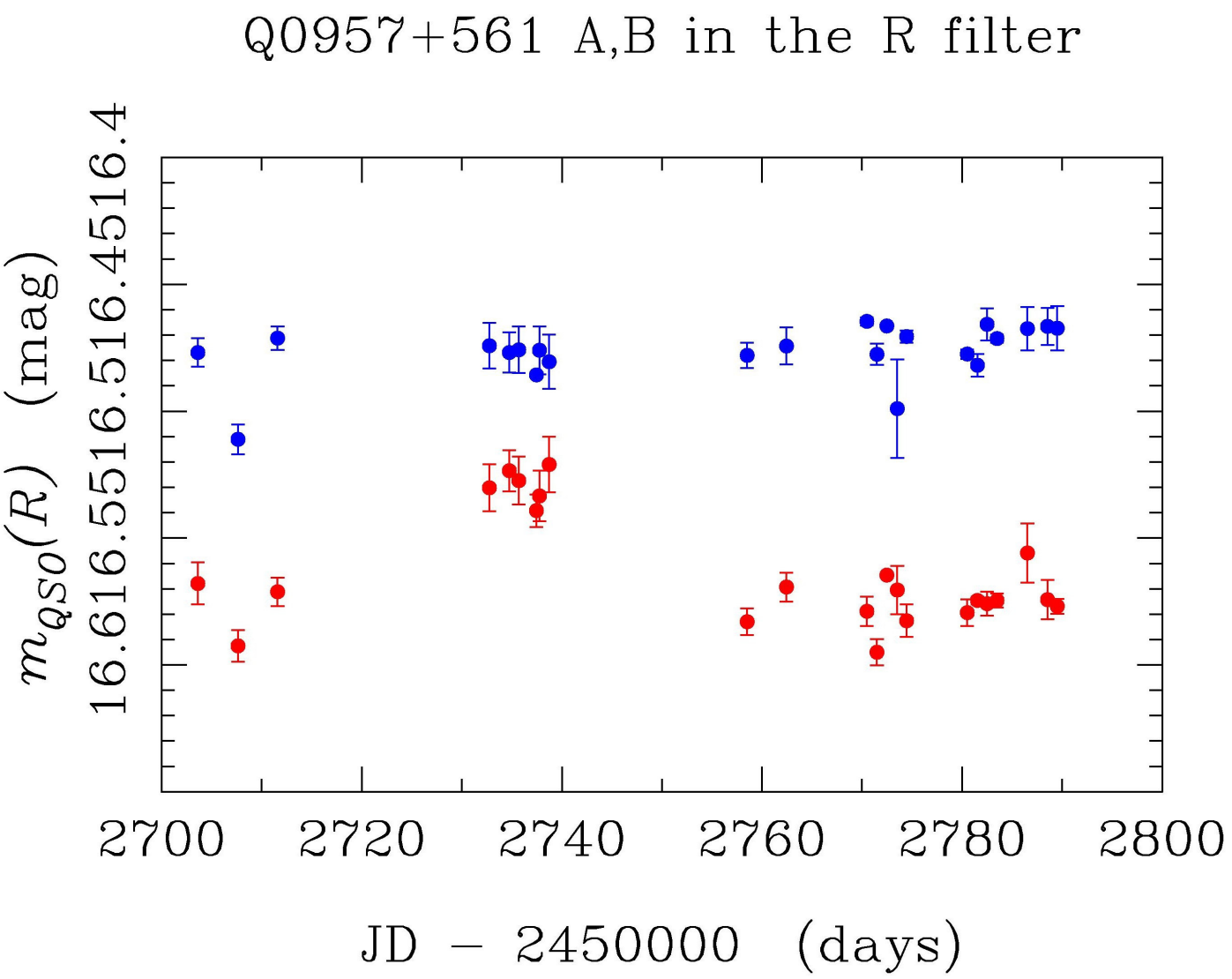
- We find a big gap between 2720 and 2760.....bad weather

- WHAT CAN WE DO?

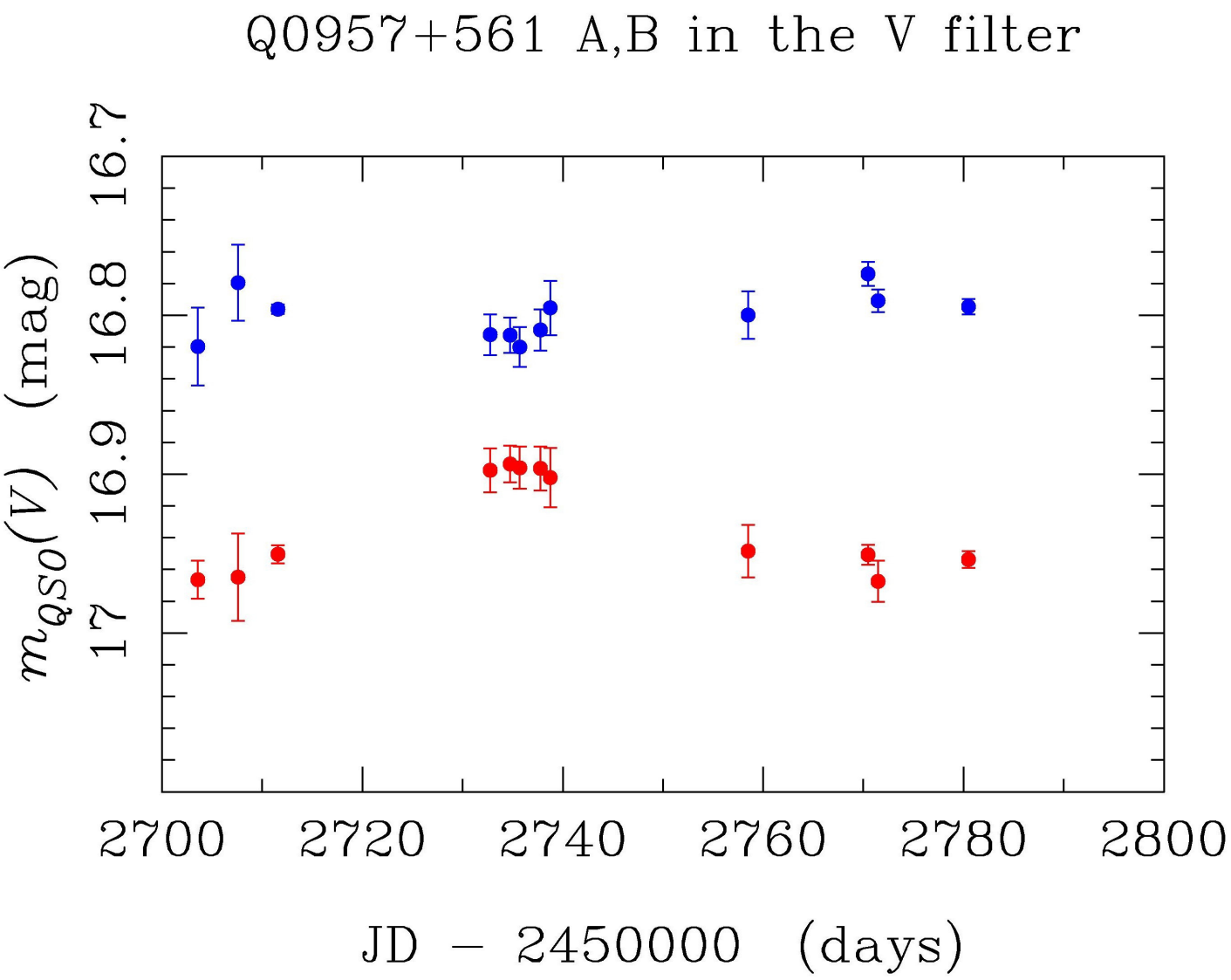
- We got some “extra” data (five nights in that gap) of Rudy Schild (Mount Hopkins Observatory)

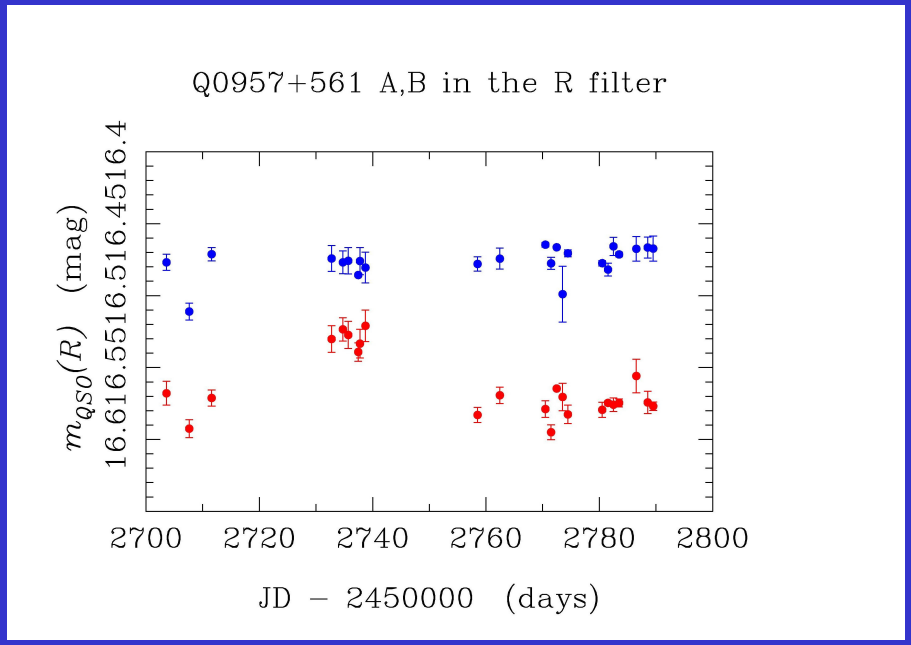
- We will see what happens....

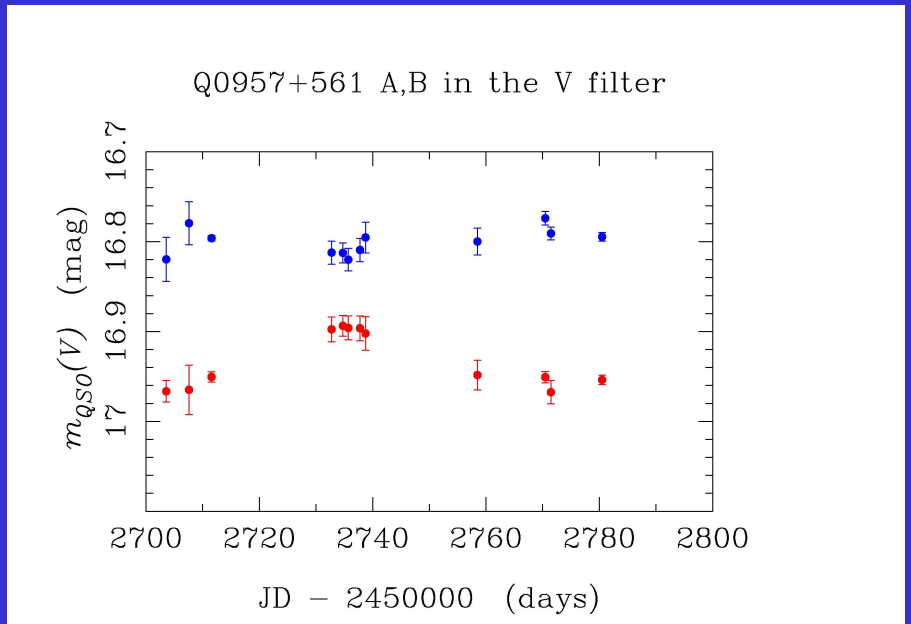
It seems to be an event in the A component with an amplitude less than 50 mmag



It seems to be an event of 60 mmag in the A component

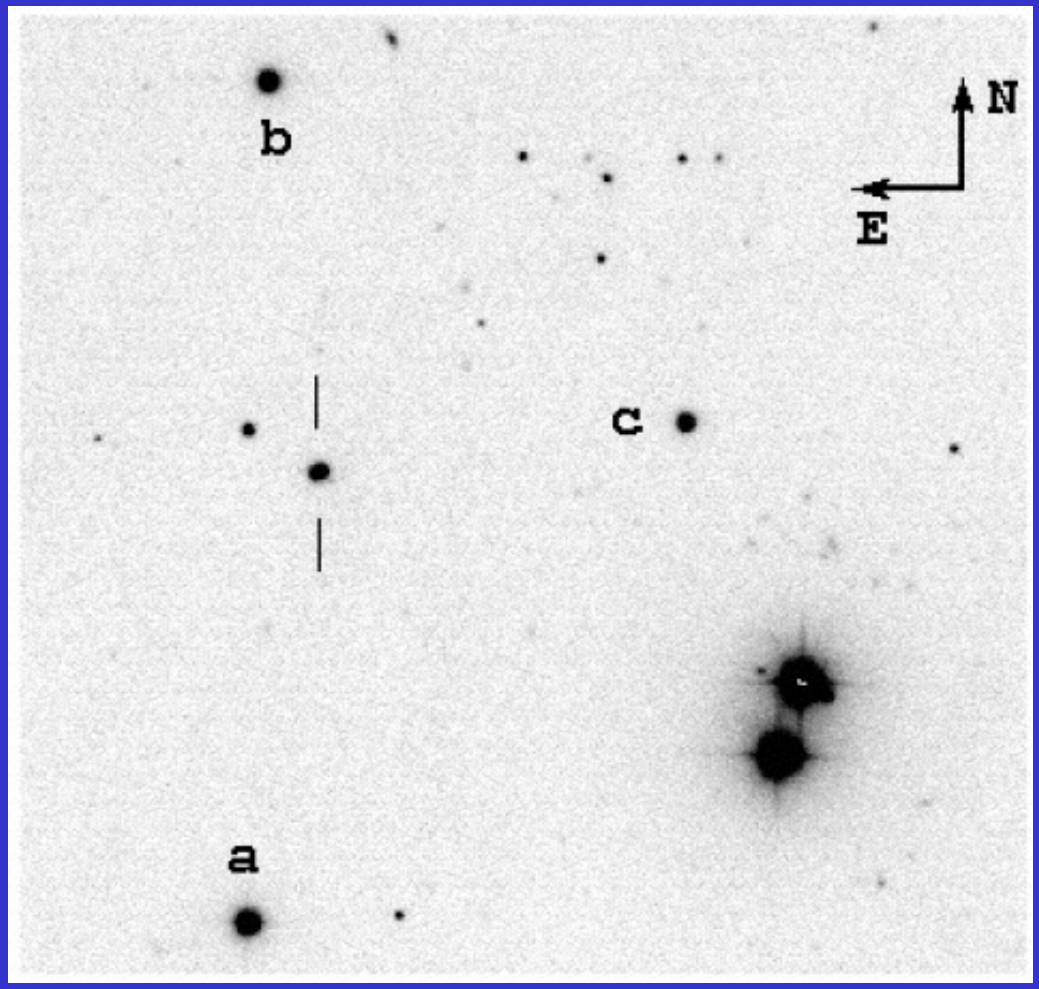





# Comparison between both filters

# ➢SBS 0909+532: another double quasar



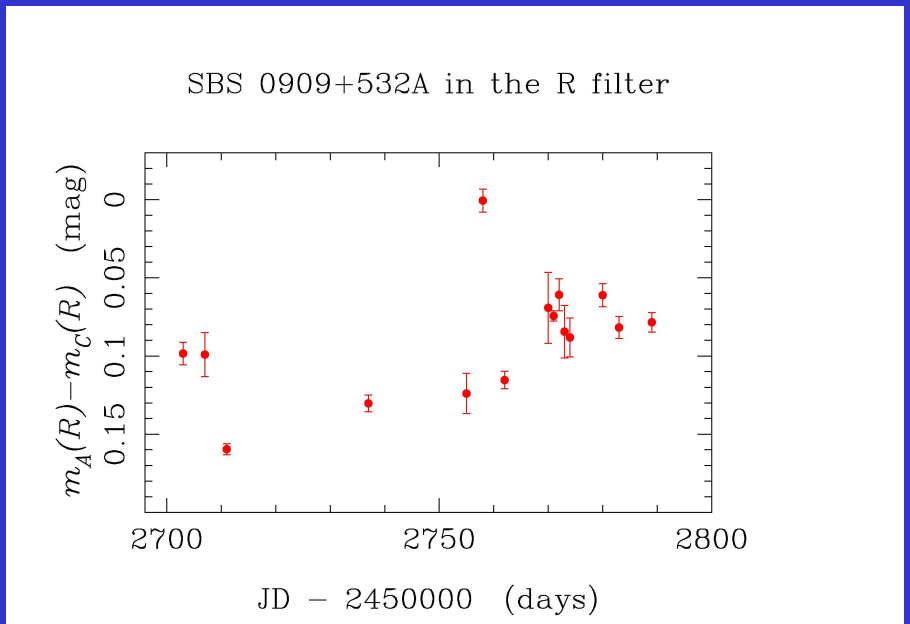

z = 1.377

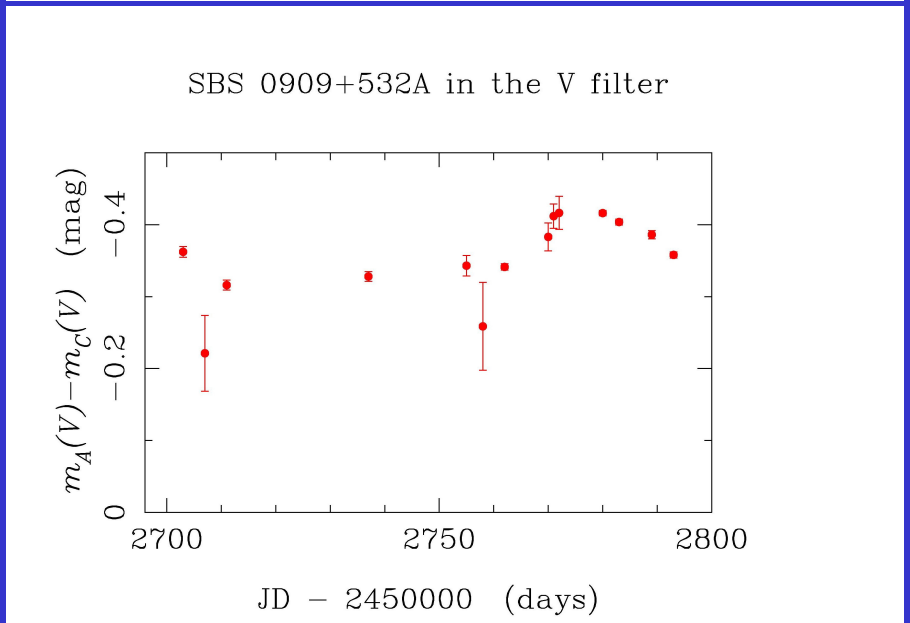
B = 17.0

Separation between images: 1.107 +/- 0.006 arcsec

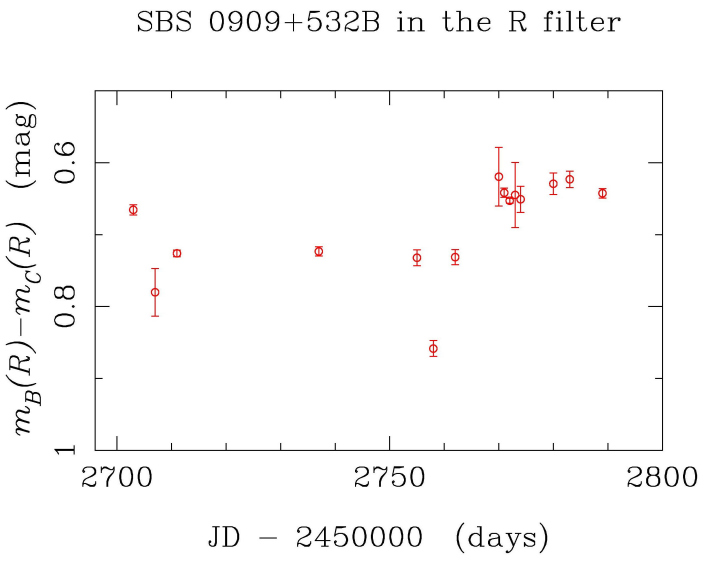
Despite it is not a very studied system,it is probed that SBS 0909+532 is a gravitational lens

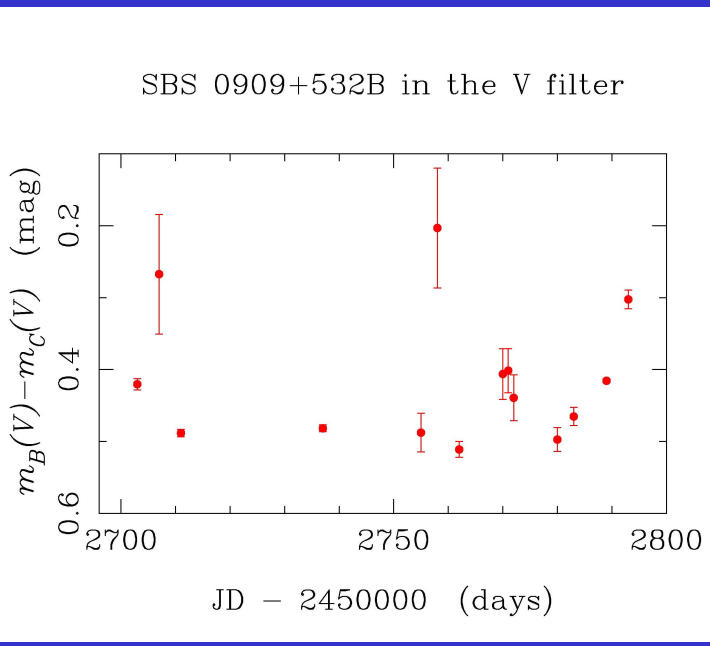
The lens redshift is z = 0.83



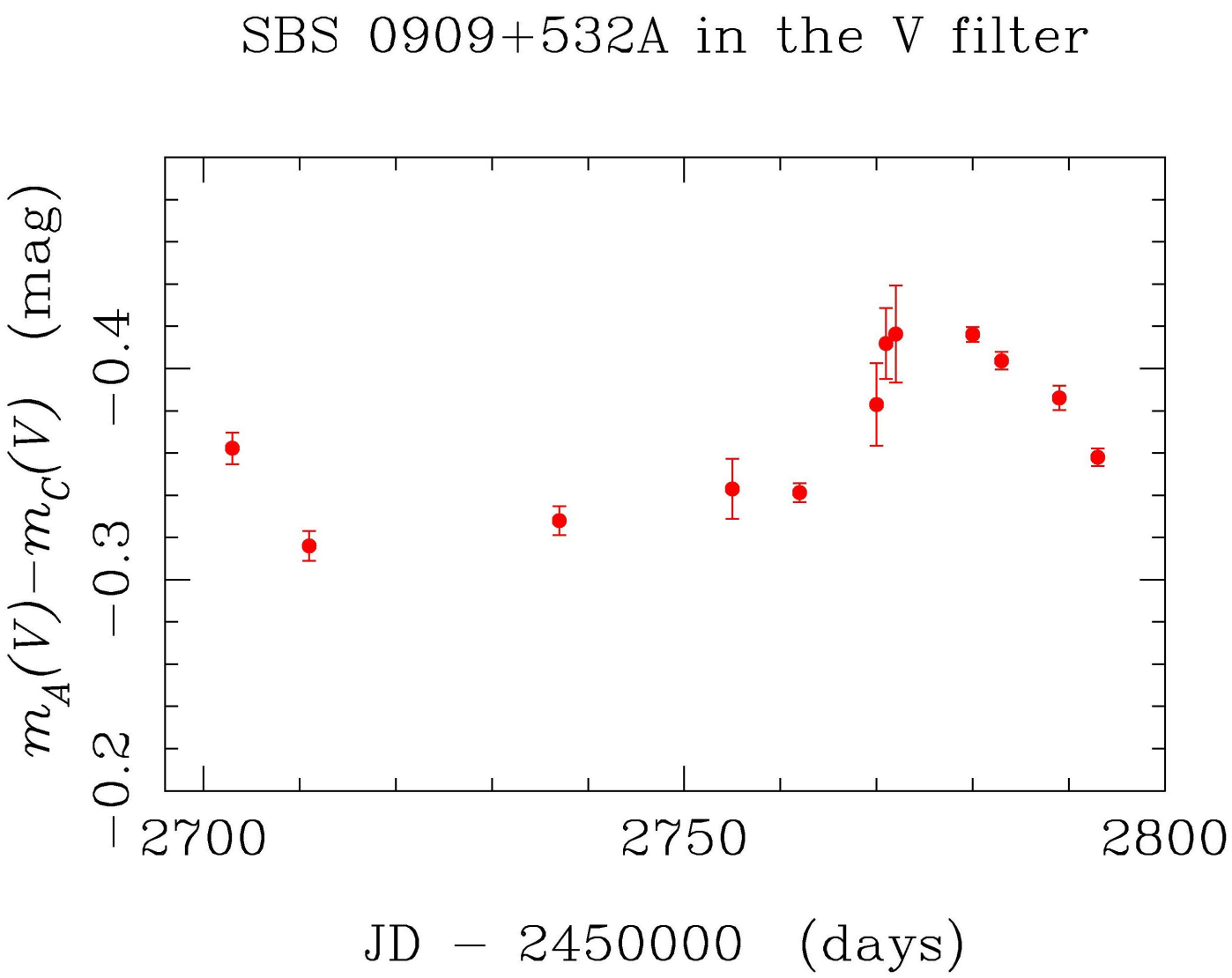

SEE BEHAVIOUR

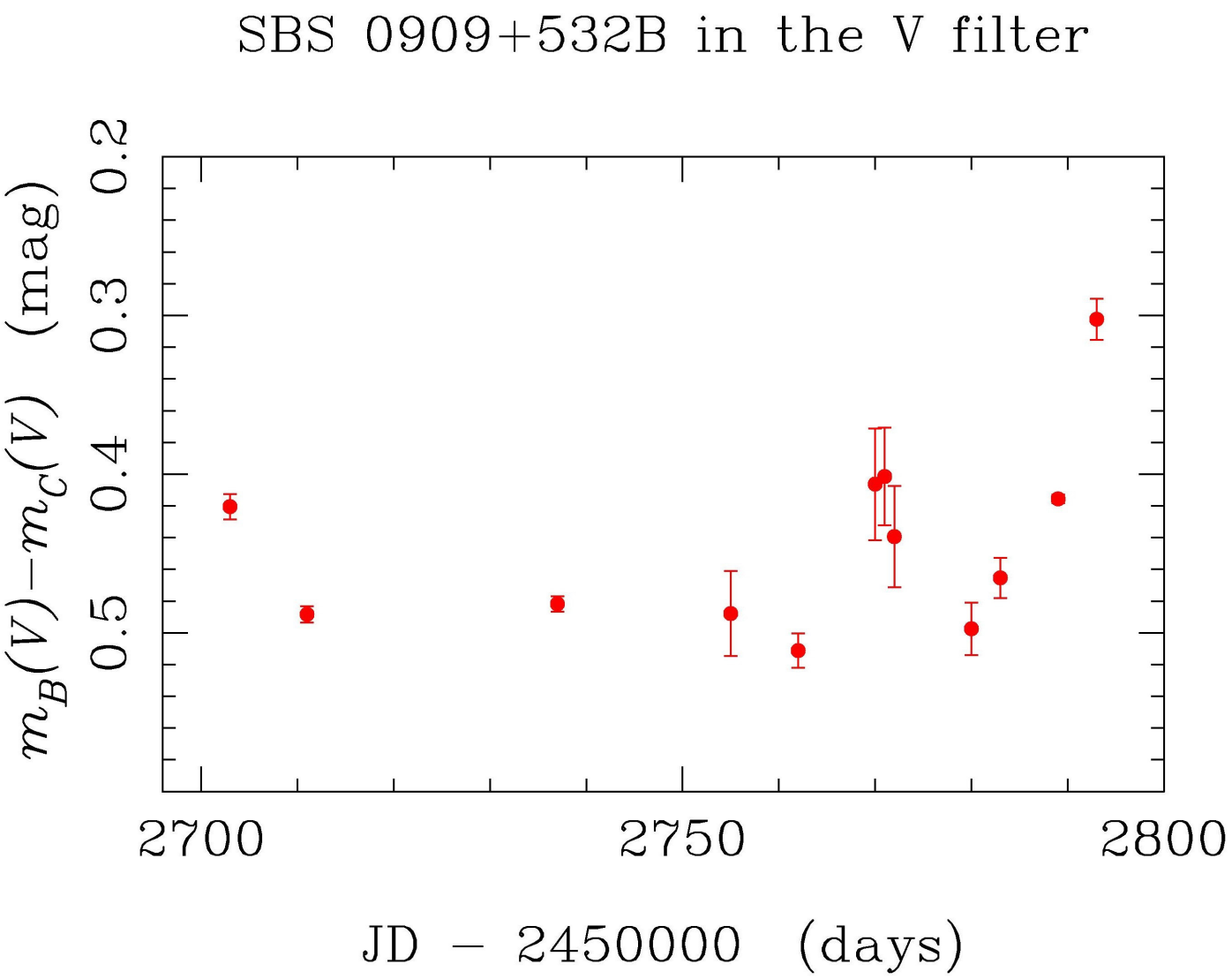


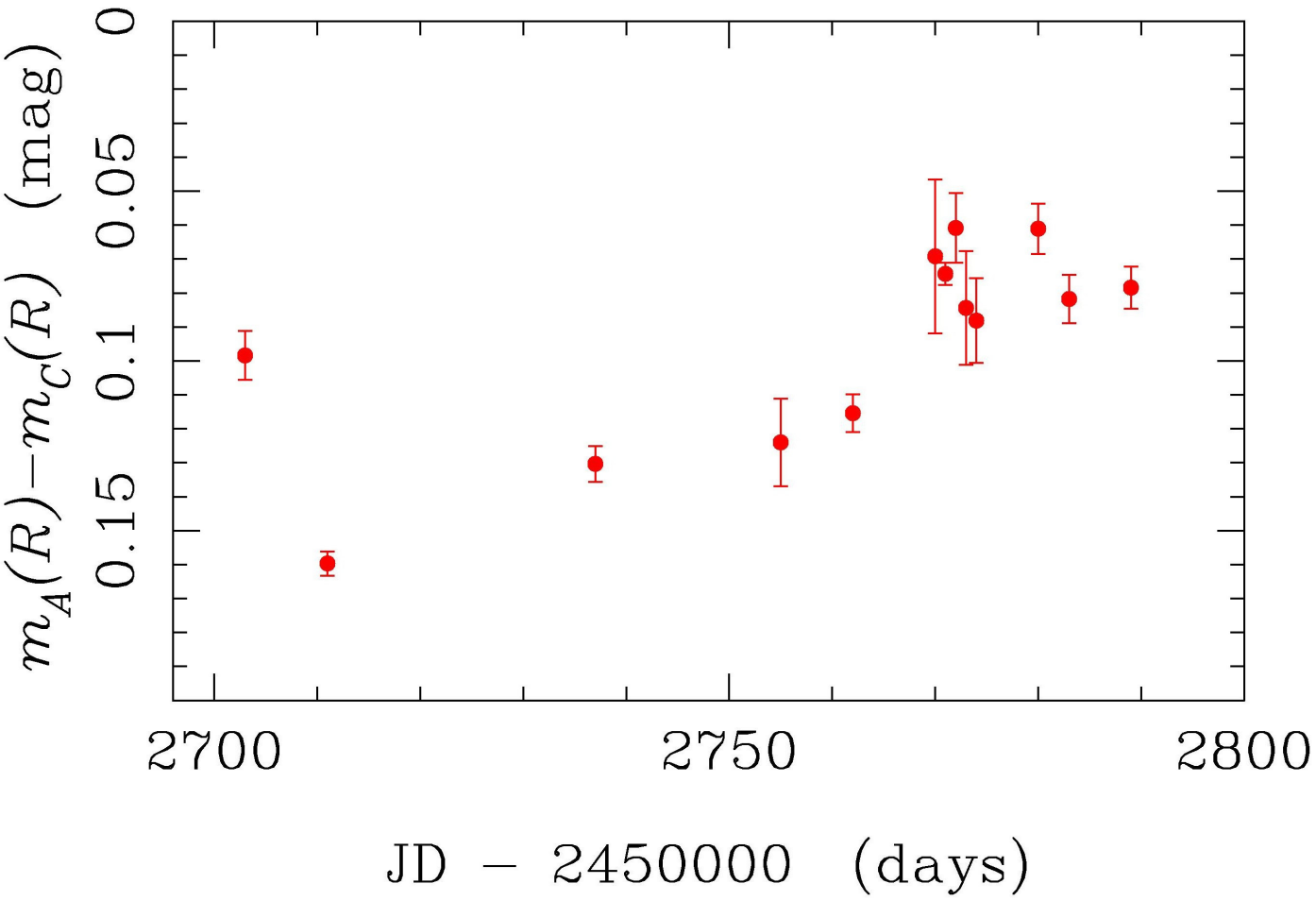



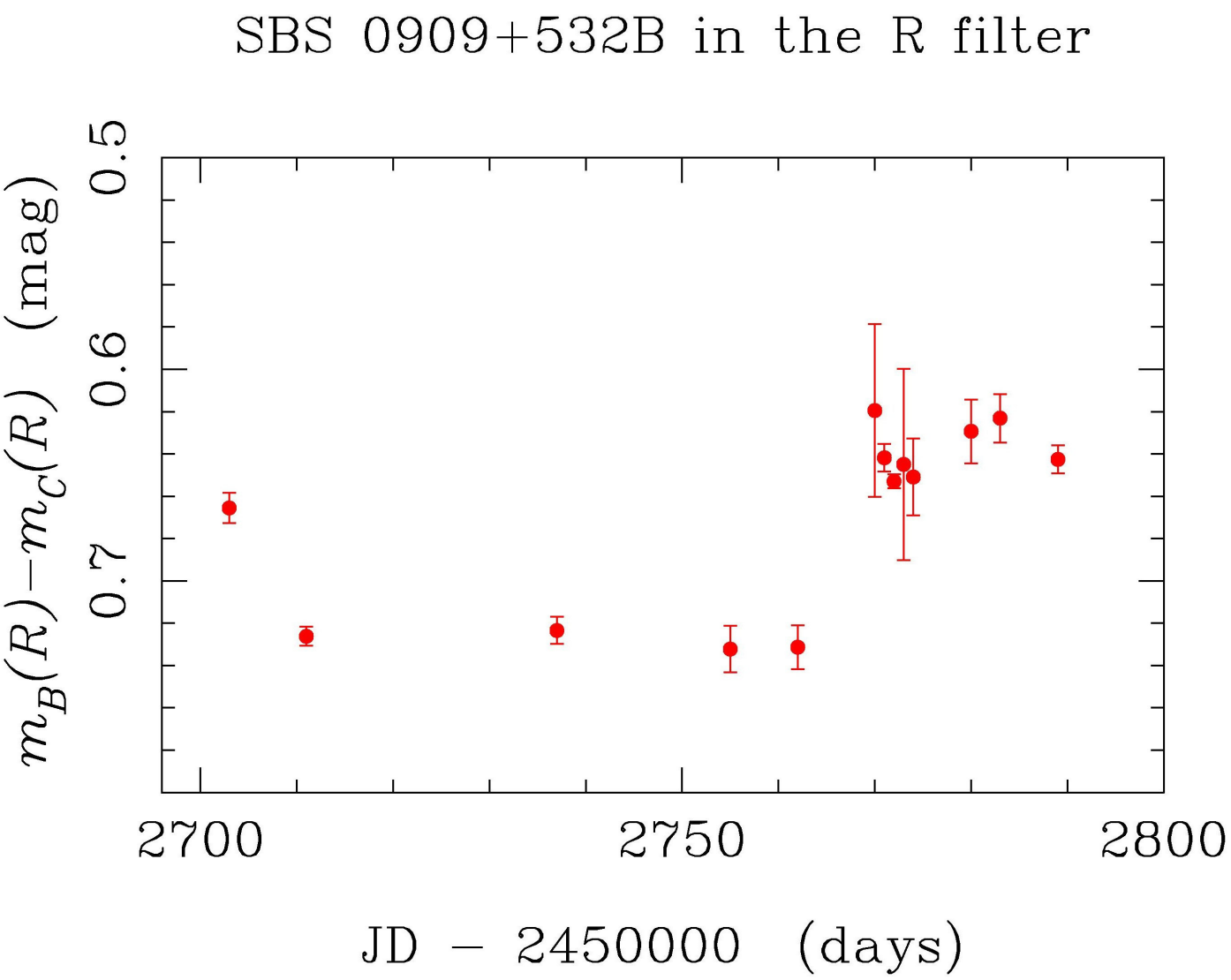

TWO VERY BAD NIGHTS: 2707 AND 2758

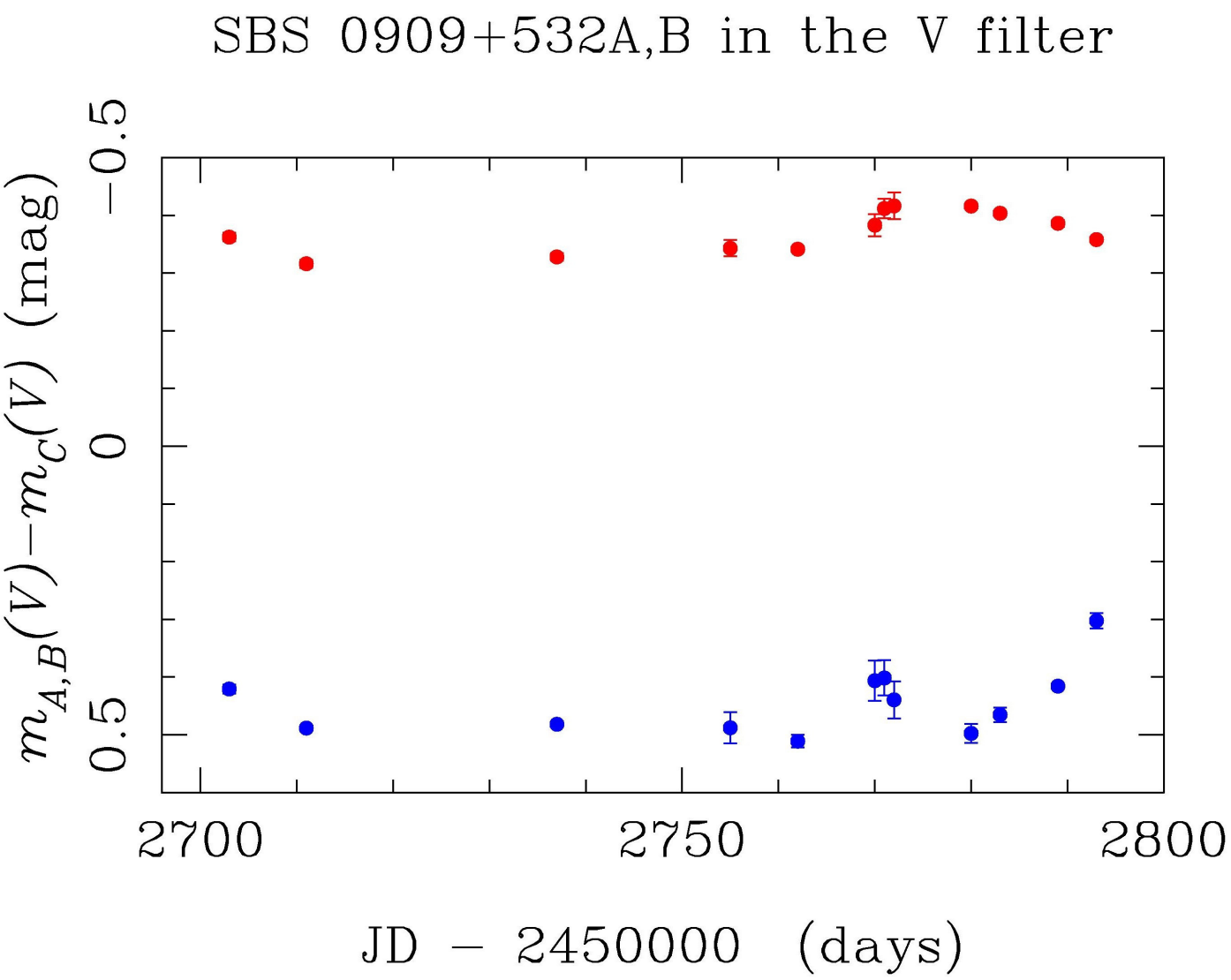
IN BOTH FILTERS!!

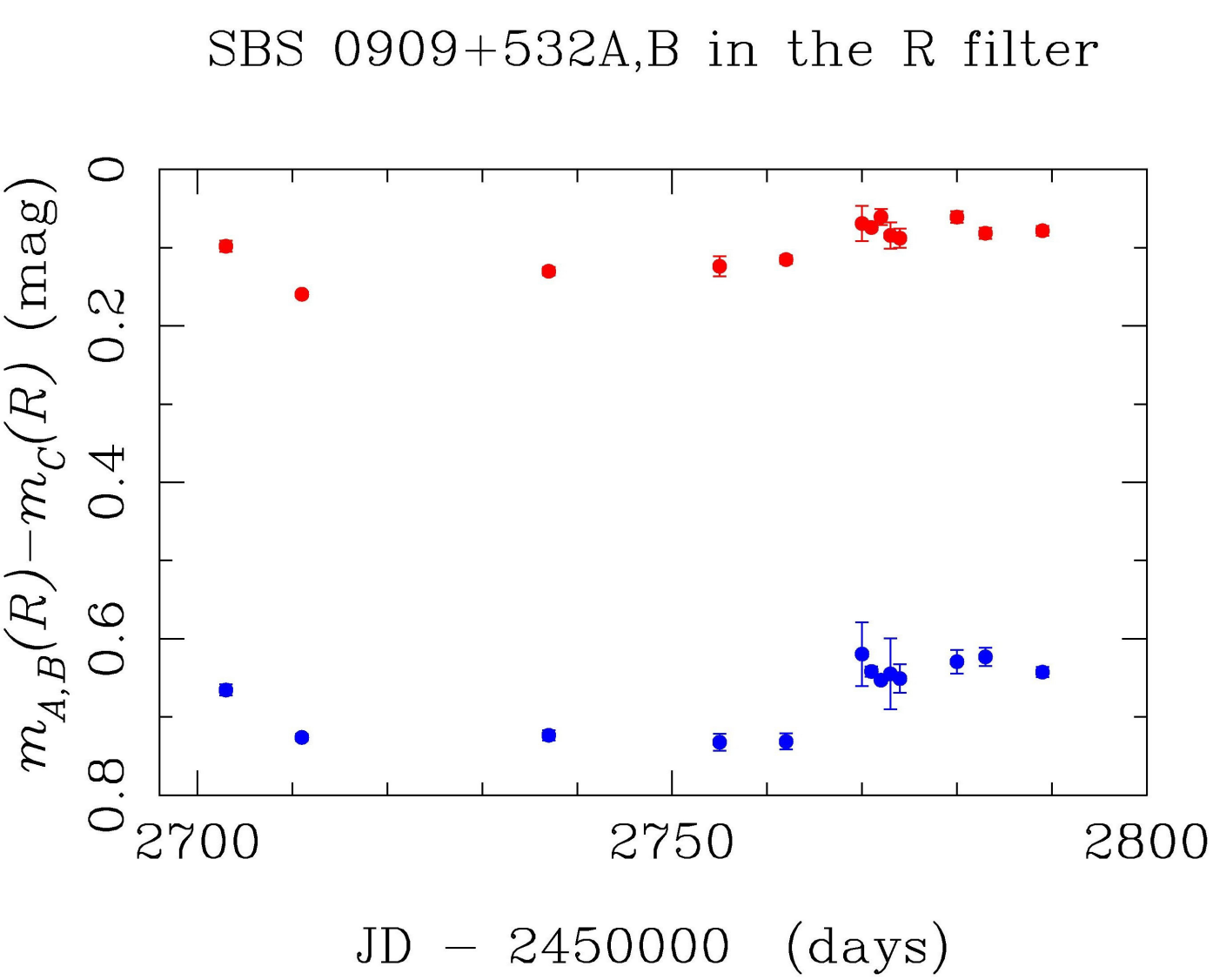

SBS 0909+532A in the V filter
$m_A(V) - m_C(V)$ (mag)
−0.2
−0.3
−0.4
2700
2750
2800
JD − 2450000 (days)


SBS 0909+532B in the V filter
$m_B(V) - m_c(V)$ (mag)
0.2
0.3
0.4
0.5
2700
2750
2800
JD − 2450000 (days)


SBS 0909+532A in the R filter
$m_A(R) - m_C(R)$ (mag)
0.15
0.1
0.05
0
2700
2750
2800
JD − 2450000 (days)


SBS 0909+532B in the R filter
$m_B(R)-m_C(R)$ (mag)
0.5
0.6
0.7
2700
2750
2800
JD − 2450000 (days)


SBS 0909+532A,B in the V filter
$m_{A,B}(V) - m_C(V)$ (mag)
−0.5
0
0.5
2700
2750
2800
JD − 2450000 (days)


SBS 0909+532A,B in the R filter
$m_{A,B}(R) - m_C(R)$ (mag)
0
0.2
0.4
0.6
0.8
2700
2750
2800
JD − 2450000 (days)

## ➢The two isolated quasars: PG1427 and PG1626

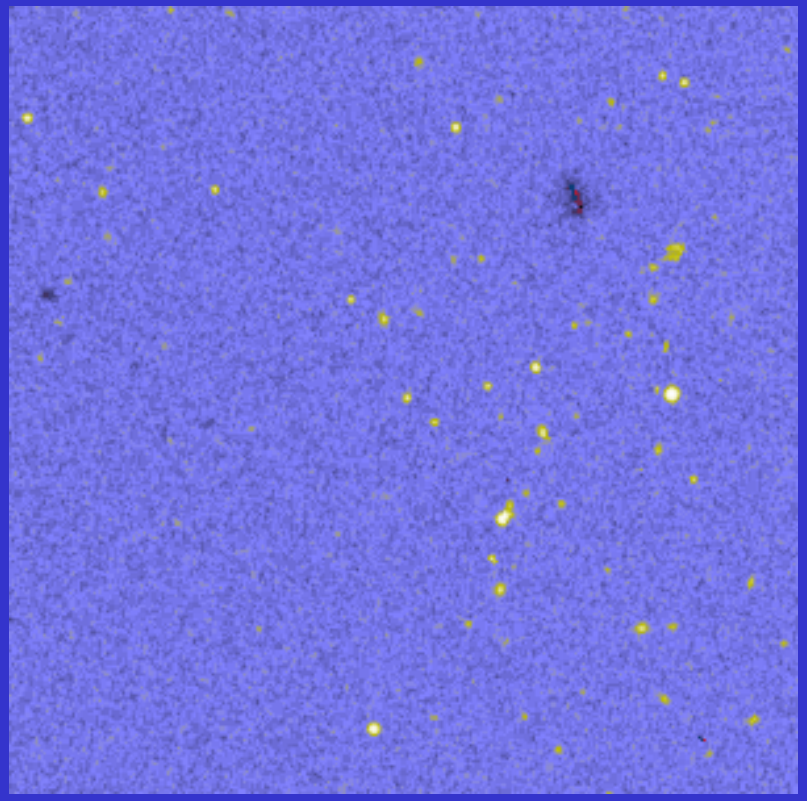
➢For these systems we wanted to find variability on time scales of a few days (1-10 days), less than our period of sampling

➢ To test the cromaticity or acromaticity of the variability

➢ To compare with quasars afected by gravitational lensing

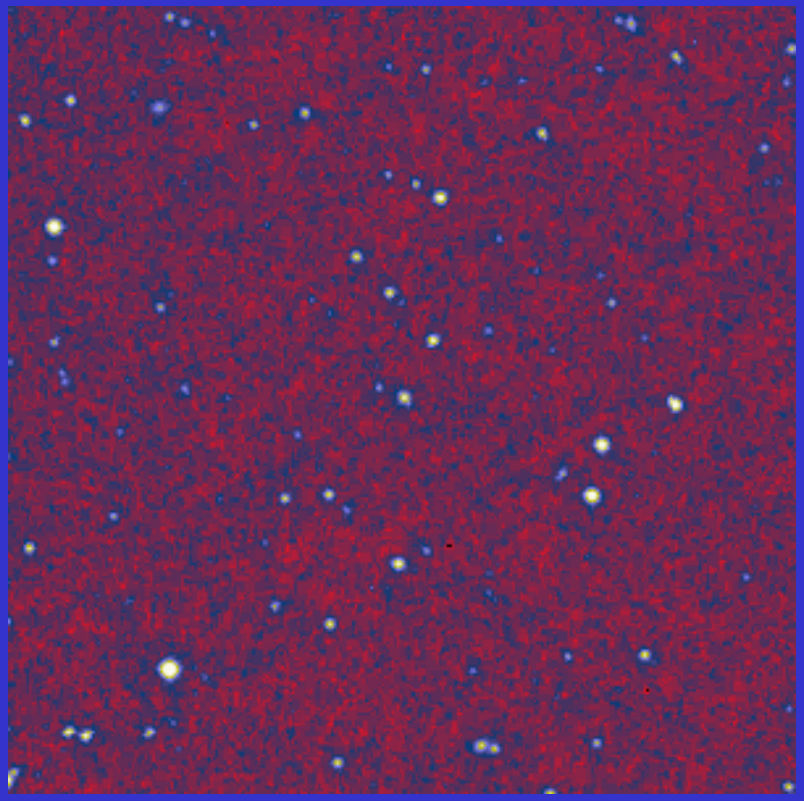
PG 1427+48

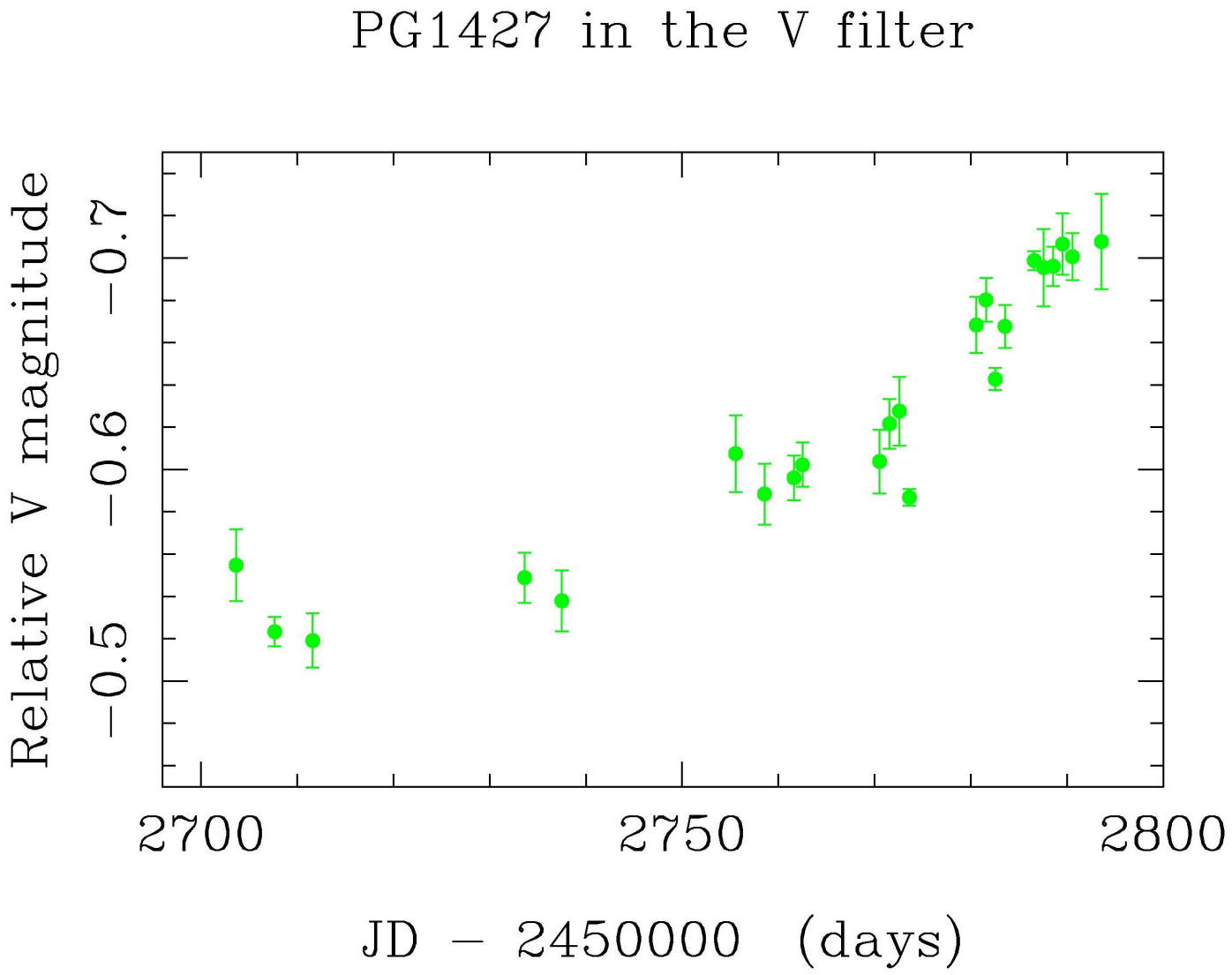
z = 0.220

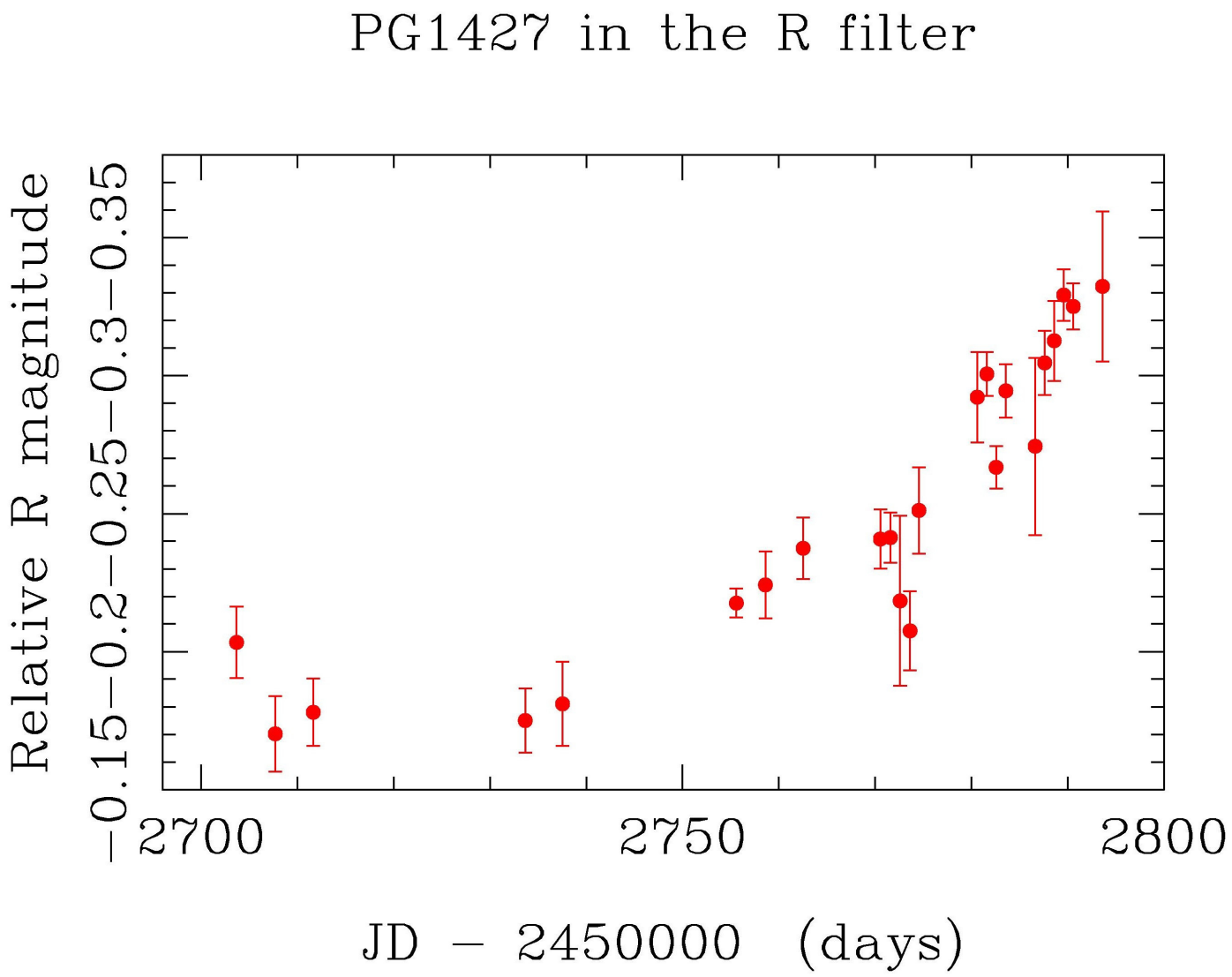


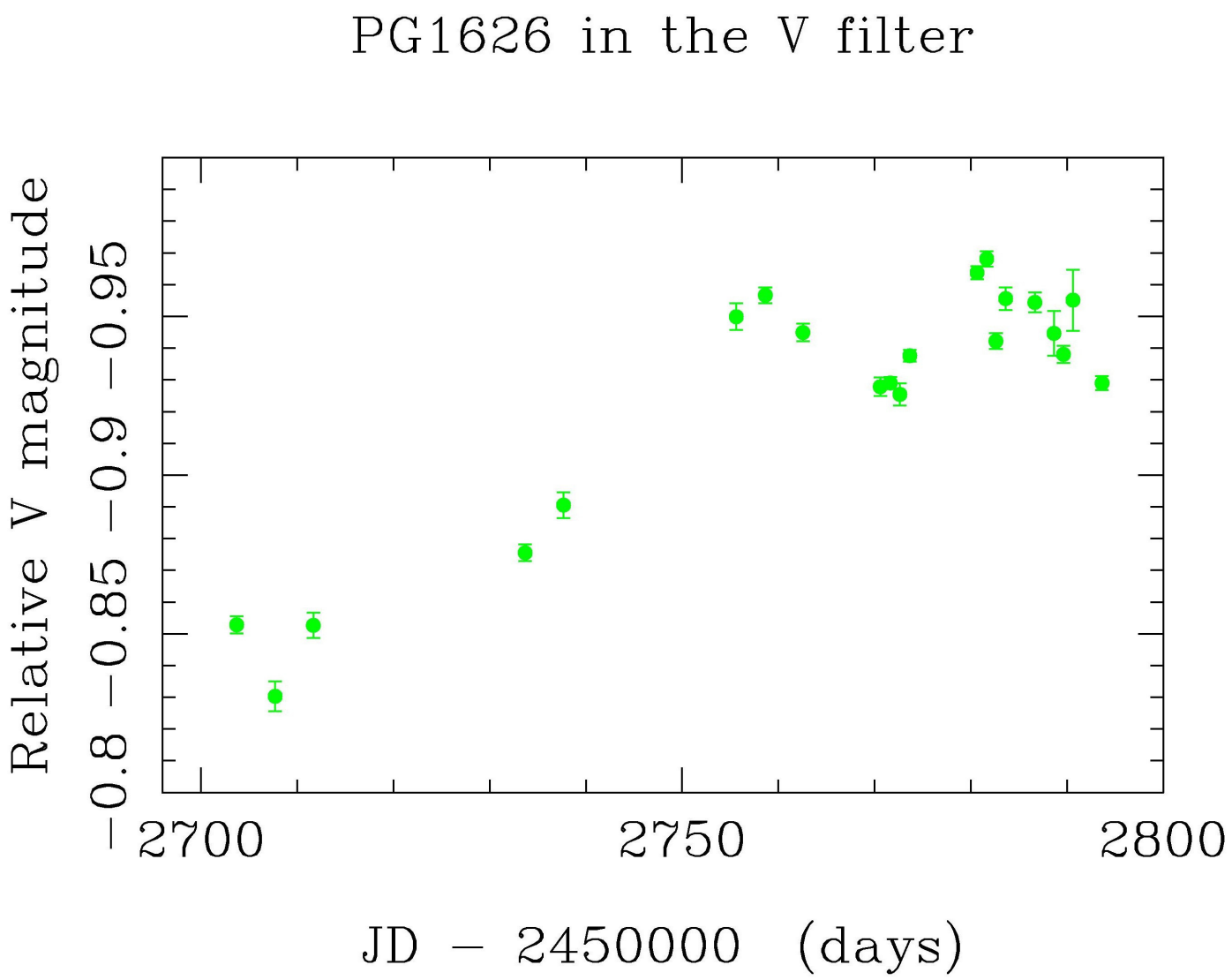
PG1626+55

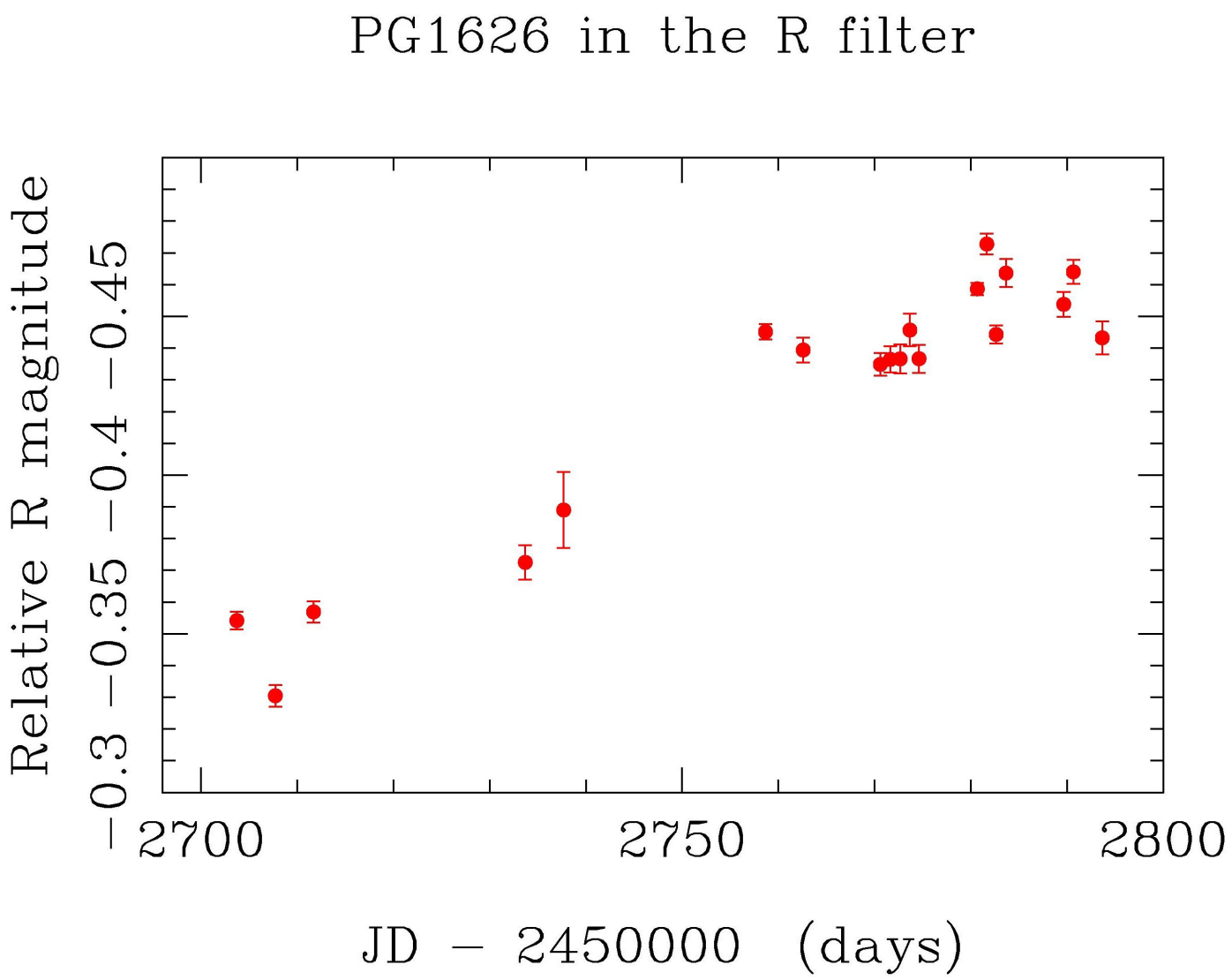
z = 0.133




PG1427 in the V filter
Relative V magnitude
−0.5
−0.6
−0.7
2700
2750
2800
JD − 2450000 (days)


PG1427 in the R filter
Relative R magnitude
−0.15
−0.2
−0.25
−0.3
−0.35
2700
2750
2800
JD − 2450000 (days)

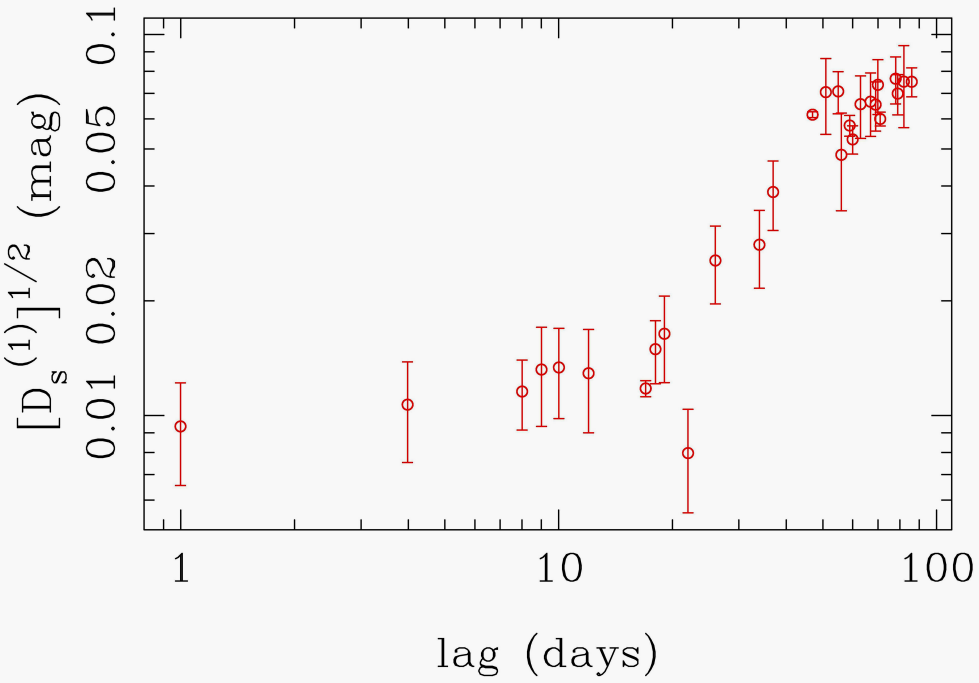

PG1626 in the V filter
Relative V magnitude
−0.8
−0.85
−0.9
−0.95
2700
2750
2800
JD − 2450000 (days)


PG1626 in the R filter
Relative R magnitude
−0.3
−0.35
−0.4
−0.45
2700
2750
2800
JD − 2450000 (days)

The structure function in the R band, for an arbitrary **lag** (temporal separation) is

$$\mathbf{D_s^{(1)} = (1/2N)\ \Sigma_{ij}\ [(m_j - m_i)^2 - \sigma_i^2 - \sigma_j^2]}\ ,$$

for **pairs (i,j)** that verify $\mathbf{t_j - t_i \approx lag}$ ($\mathbf{N \geq 2}$).

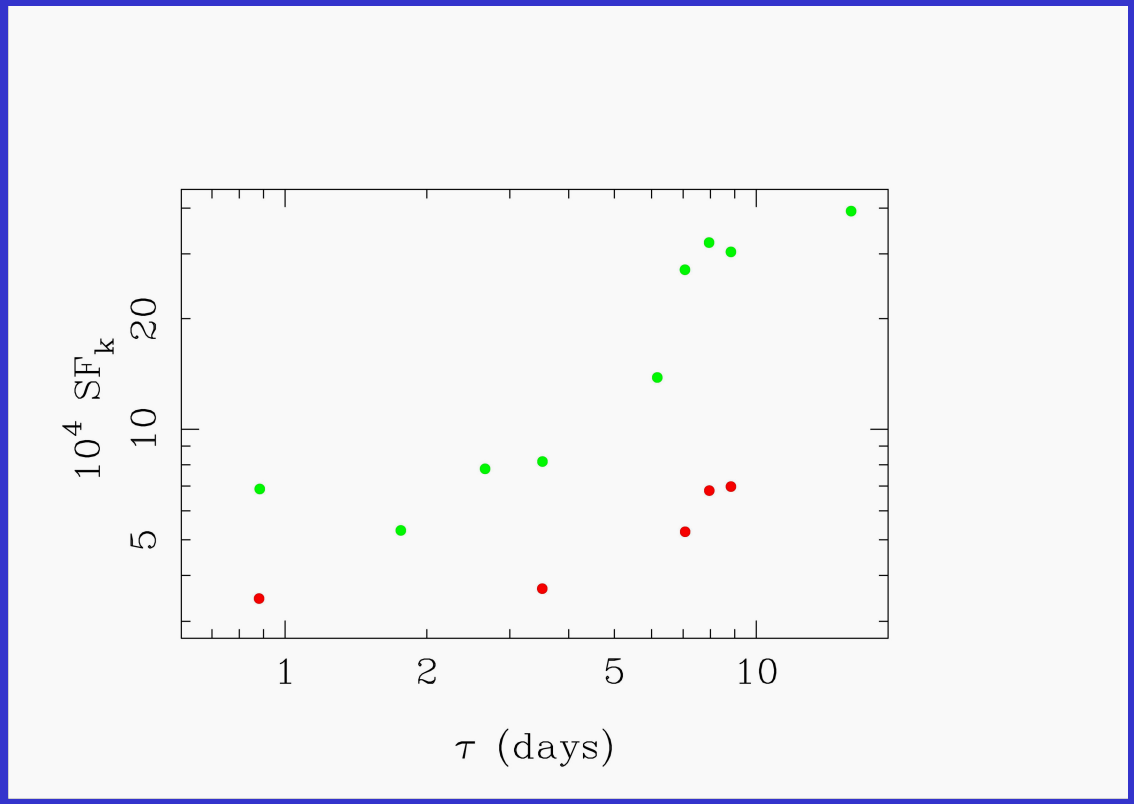


**$SF_k$** is **$k^2 \times SF$** (SF is the intrinsic structure function of L, NOT of apparent magnitude)

m (obs) $\rightarrow$ **k $\times$ L (cte $\times$ luminosity)**

t (obs) $\rightarrow$ **T (rest frame time)**

**$N \geq 6$  K= f(λ)**



THE END