

# SDSS Stripe 82 : quasar variability from forced photometry

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## ABSTRACT

### 1 INTRODUCTION

### 2 DATA ANALYSIS

We use data from all SDSS runs up to and including run 7202 (Data Release 7), including all 6 SDSS camera columns.

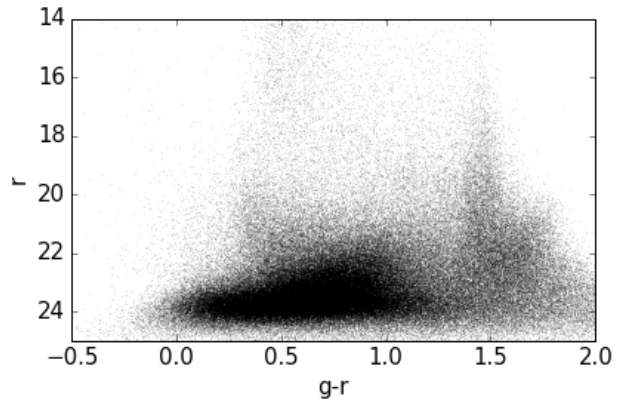
All epochs (individual images) were background-subtracted, and then scaled from the Digital Unit counts to fluxes by comparing standard objects against the Ivezić+2007 catalog (similar to Jiang+2014).

The data were coadded, and all objects detected in the i-band coadds were assigned a deepSourceId (== objectId). For star-galaxy separation, the entire clump was considered as one parent source (with single ParentSourceId). For an object which is a parent (eg. a galaxy), ParentSourceId is null. This amounts to 40 million i-band detections down to  $3\sigma$ . 8 million of those are brighter than  $23^{\text{rd}}$  mag. Thus the total number of photometric measurements is : (40 million i-band detections)  $\times$  (80 epochs)  $\times$  (5 filters) = 16 billion measurements, including (8 million i-band detections  $i < 23$ )  $\times$  (80 epochs)  $\times$  (5 filters) = 3 billion measurements brighter than  $23^{\text{rd}}$  mag.

Forced photometry was performed in u,g,r,i,z on the individual epoch images (NOT difference imaging), in locations specified by i-band coadds. (DIFFERENCE imaging is when photometry is done on coadd - individual-epoch-image) . Therefore in some cases the flux reported for a given aperture is negative, because after background subtraction noise oscillates around 0, and when it is scaled up, it can have negative values. [stored in rawDataFPSplit ]

The average brightness of an object in a given filter can be found in two ways. The median of the forced photometry values (over all epochs, including the negative fluxes) will better reflect the actual brightness of a variable source. This may mean that the median is negative, i.e. the median flux is negative. Since the magnitude is undefined for negative fluxes, we then revert to the lightcurve, and for each exposure with negative flux we find the zero point magnitude ( $m_1$ ) - the magnitude for a source with a flux of 1 count per sec, different for each exposure. The zero point magnitude for each exposure with negative flux is calculated from the Flux of 0 magnitude source,  $F_0$ , as  $m_1 = 2.5 \log_{10} F_0$ . For that object the new median magnitude in that filter will be the upper limit.

Colors can be calculated in two ways: using the median of forced photometry over all epochs (object detected



**Figure 1.** A color-magnitude plot, analogous to Figure 2 from Ivezić+2003 . We use only 200 000 sources, corrected for galactic extinction, plotting the median photometry over all epochs only for sources where median flux is not negative.

in coadded i-band has photometry in all epochs), or the median over single-epoch detections (only when an object was above the detection threshold for a single epoch). Thus the median over all detections will be biased (especially for faint sources) towards higher brightness. On the other hand, the median over all epochs will be more representative of the true brightness of an object in a given filter. If a median brightness is negative, we use zero point magnitudes and in such cases median over all epochs will be an upper limit on brightness, but still less biased than median over all detections. Therefore we choose to use median over all epochs to calculate colors (see Fig. 3 for an example).

Since the reported fluxes are not extinction-corrected, we use a table of  $E(B-V)$  in a direction of a given source to correct for the galactic extinction. We use the formula  $x_{corr} = x_{obs} + A_x * E(B-V)$ , where  $x$  is u,g,r,i,z , and  $A_x$  is 5.155, 3.793, 2.751, 2.086, 1.479 for each filter respectively [SOURCE? ]

### 3 RESULTS

### 4 CONCLUSIONS

### ACKNOWLEDGEMENTS

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