Performance of CQUEAN camera

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Abstract

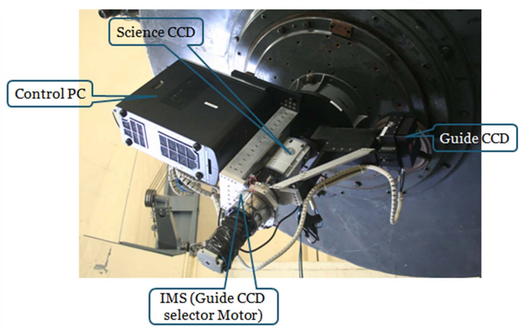
CQUEAN (Camera for QUasars in EArly uNiverse) is a newly developed camera system by CEOU optimized at 0.8 – 1.1㎛ wavelength region. From Aug. 10 to Aug. 17, 2010, the camera was installed at 2.1m Otto Struve telescope at McDonald Observatory, USA, and engineering test observation was performed. We obtained the data for the characteristics of camera and scientific purpose using 7 filters (g, r, i, z, Is, Iz, Y). For the purpose of discovery of z – 5~6 quasar, we specially used new filters (Is,Iz). During the test observation, we obtained the data of Gamma-Ray Burst, high redshift quasars, high redshift quasar candidates and other calibration data. We present general characteristics of the reduced data taken with CQUEAN and show the performance of the camera.

CQUEAN

CQUEAN (Camera for QUasars in EArly uNiverse) is a newly developed camera system by CEOU optimized at 0.8 – 1.1㎛ wavelength region. To find out high red-shift quasars(z>5.5), CQUEAN is designed to perform good imaging at near 1 ㎛ region with newly adopted filter (Is,Iz,Y). *Focal reducer* and *auto-guiding system* is developed and attached on it. Detailed information about CCD and pictures of system are described below.

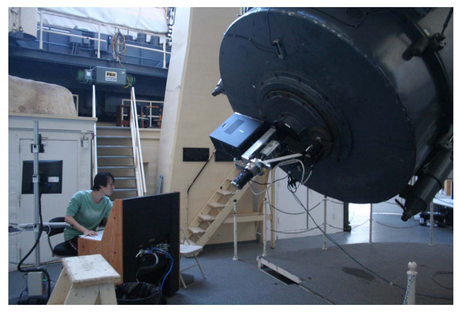
CCD	E2V Deep Depletion Chip
Format and pixel size	1024 x 1024, 0.276" (13 micron)
FOV	4.7' x 4.7' (with focal reducer)
QE	90% at 0.8 1 μm, 25% at 1 μm
Readout time	1 sec
Readout noise	4 DN (check)
Dark Current (@-70)	0.1 - 0.2 e-/sec
Gain	1.2
Fringe	None
Filters	SDSS g,r,i, LSST z,Y, is, iz
Linearity	< 35,000 DN

CCD properties of CQUEAN camera

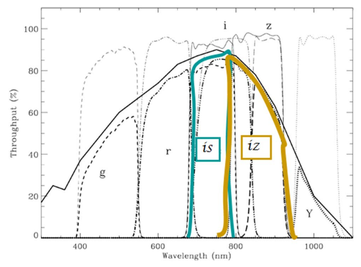


ANDOR-M NIR camera and CQUEAN system

Installation & Test Run



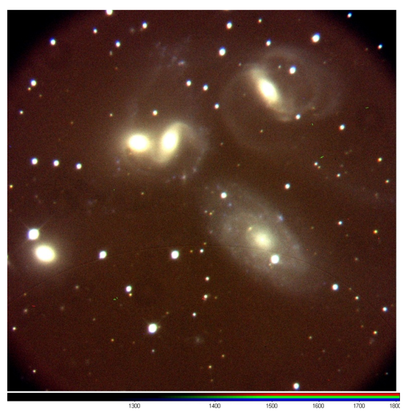
From Aug. 10 to Aug. 17, 2010, the camera was installed at 2.1m Otto Struve telescope at McDonald Observatory, USA, and engineering test observation was performed. Under good weather condition(seeing ~0.8"at best), we obtained data of known QSOs, high redshift QSO candidates, GRB afterglow and properties of the system. As results, Here we present performance of CQUEAN system, reduction process of scientific data and preliminary results from test run.



Filter	λ_{eff} (μm)	Sky Count (DN/sec)	Sky Brightness (mag/aresec2)	Magnitude Limit (mag at 5-σ, 1hr integration)	T_{eq} (sec)
r	0.623	4.1	19.8	23.4	15.2
i	0.768	11.1	19.7	23.8	6.1
is	0.739	8.4	19.7	23.7	8.0
iz	0.849	11.7	19.3	23.5	5.3
z	0.877	8.4	19.1	23.1	8.1
Y	0.991	6.2	17.9	21.8	10.8

Transmission curve of CQUEAN camera and filters (left) and calculated limit magnitude for each filters(right table)

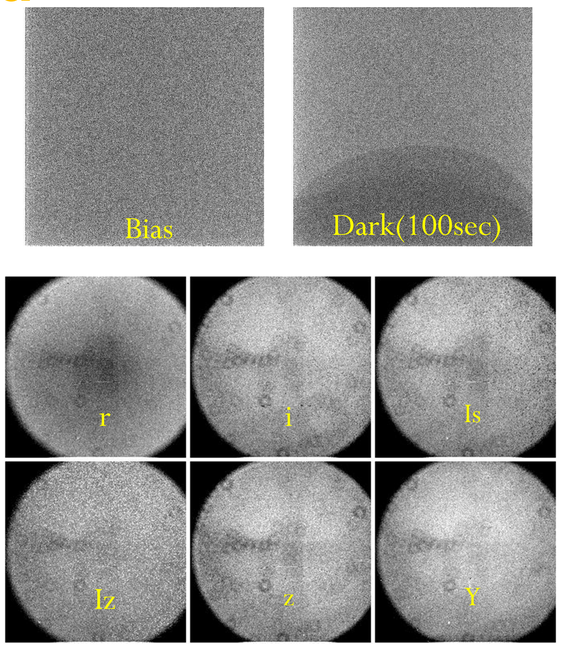
Properties of CQUEAN data



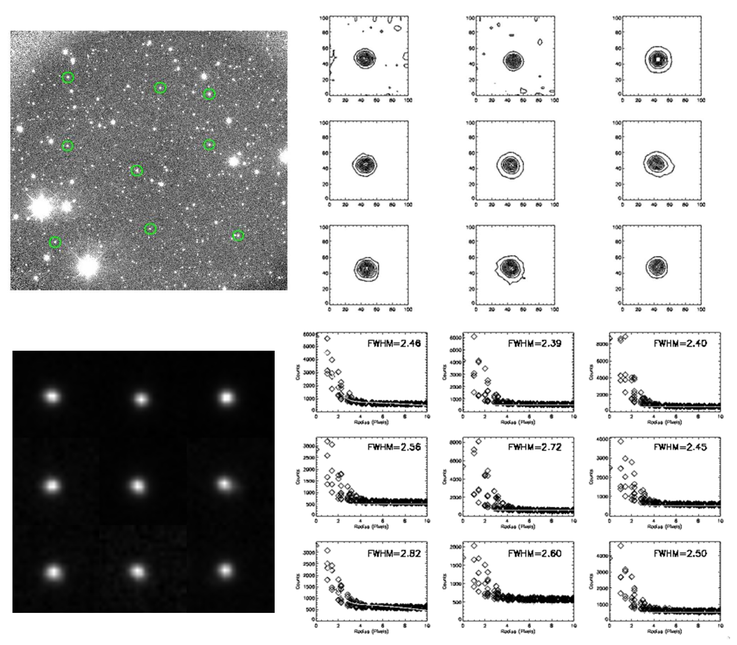
The first light image,
'Stephen's Quintet(r,I,z 180sec)

- Fringe is *not* shown in long wavelength region
- Vignetting pattern is shown at 4 corners, and can be corrected with flat fielding
- Field of view : 4.7' x4.7' with focal reducer
- Limiting magnitude : i = 24.3 with S/N=5, after 1 hour integration

- Bias is uniform over whole pixel (~4460 ADU, 2 ADU variation)
- Dark current is 0.1-0.2DN/sec (higher dark current at the upper part of the chip) and sufficiently less than typical sky background (6x less than the r-band sky flux)

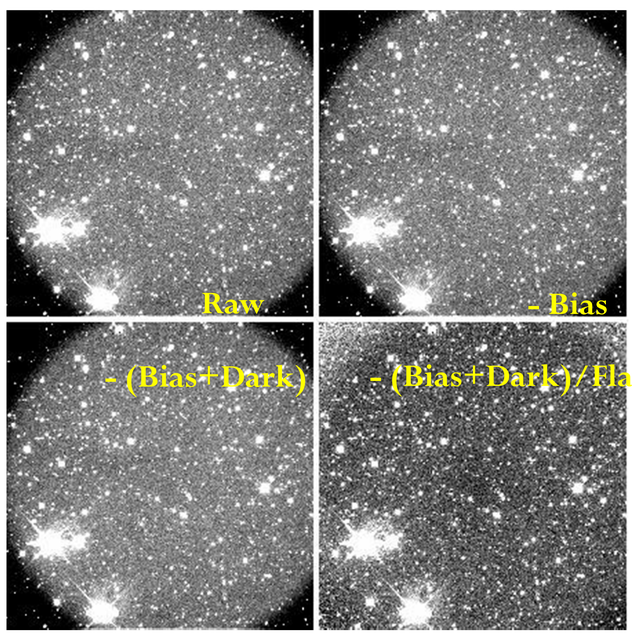


Flat images of each filters



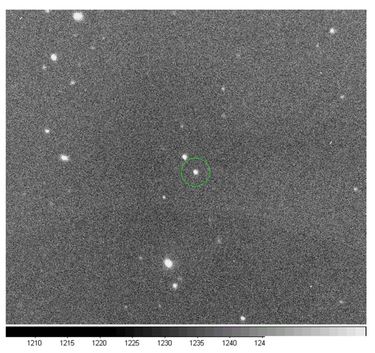
Y-band imgge of NGC6633 of 60sec, contour, radial profile and stellar images extract each 9 pieces of image (clockwise).

Reduction process and results

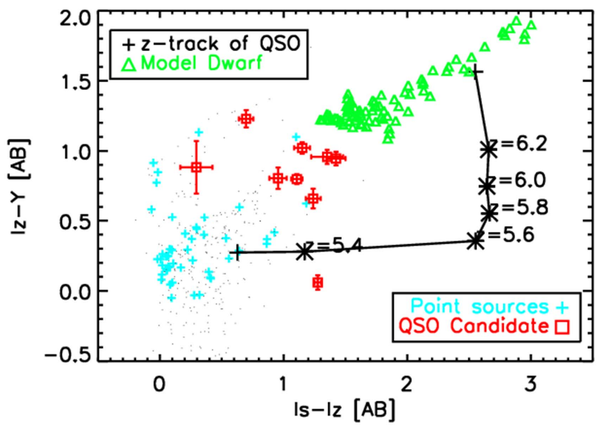


Reduction process and results of 60sec exposure frame of NGC6633

- We reduced the data with typical optical CCD reduction process. Bias, Dark subtraction and flat fielding are adjusted, and corrected well.
- We are working on the properties of CCD and function of auto-guiding system.
- We proposed high red shift QSO candidate observation to Mcdonald Observatory based on the results ofTest run.
- CQUEAN demonstrated its good imaging capability of GRB afterglow follow-up.



GRB100804A afterglow in z-band



- Quasar selection : Is-Iz-Y color-color diagram
- By observing known high redshift QSOs and candidates we can discriminate real QSO candidates from interlopers like dwarf stars.
- GRB afterglow follow-up observation
- We observed GRB afterglow including GRB100804A and reported its detection and results to GCN circular

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