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A LARGE ARRAY OF CCDS FOR THE 1 M SCHMIDT TELESCOPE

G. Sánchez, C. Abad, and F. Della Prugna

Centro de Investigaciones en Astronomía, Mérida, Venezuela

RESUMEN

Se presenta el mosaico de CCDs instalado en la cámara Schmidt del Observatorio Nacional de Llano del Hato, Mérida, Venezuela. El mosaico consta de 16 CCDs (2048×2048). Adicionalmente el conjunto es enfriado por un sistema criogénico con el cual se alcanzan temperaturas inferiores a los −80° C. Como equipo adicional se dispone de juegos de filtros *UBUV* e *IRVB* intercambiables y un filtro pasa bajo con frecuencia de corte en 7000 Å. La cámara permite la observación en modo guiado o en modo de rastreo a la deriva. Con el telescopio Schmidt del CIDA es posible realizar observaciones en modo directo o con prisma objetivo (500Å/mm). La cámara, inicialmente diseñada para la realización del proyecto QUEST constará en una segunda fase con 96 CCDs (4096×1024). Este proyecto es una colaboración entre las Universidades de Yale e Indiana, en los Estados Unidos y la Universidad de Los Andes y el CIDA de Venezuela. El sistema está operativo desde principios de 1997 y a pesar de que aun se están efectuando calibraciones y correcciones ha sido posible la obtención de una gran cantidad de datos válidos. El tiempo de observación ha quedado distribuido de forma que la mitad de las noches oscuras están dedicadas al proyecto QUEST, con observación, en forma directa y con prisma y en modo drift-scan sobre una banda de ± 7^0 alrededor del ecuador y con filtro multicolor UBUV. El resto del tiempo está ofertado a los proyectos interesados en el uso de la cámara como el Survey for low lumisity Hx emision-line galaxies (UCM - CIDA), Variability Survey near the Galactic Plane (Yale, CFA, CIDA, Indiana), Catálogo Astrométrico de posiciones y movimientos para el área de la "Carte du Ciel" zona San Fernando (CIDA - ROA), Solar System Science (ULA - Yale).

ABSTRACT

We describe the array of CCDs (YIC Camera) attached to the Schmidt Telescope located in the Observatorio Nacional de Llano del Hato, Mérida, Venezuela. Currently the camera has 16 CCDs (2048×2048) cooled to below −80° C. The camera can be used in drift-scan mode (within 7° of equator) or guided mode. Two filter mosaics (*UBUV* and *BVRI*) and a low-pass filter with a 7000 Å cut-off are available. An objective prism of dispersion 500 Å/mm is also available. This prototype camera was designed for the QUEST project., a collaboration of Yale and Indiana Universities (USA) with the Universidad de los Andes and CIDA (Venezuela). A second phase camera will have 96 CCDs (4096×1024). The system has been working since early 1997. Even thought it is still under commisioning, an important quantity of astronomical data have been acquired. Half of the dark time is assigned to the QUEST project, observing in drift-scan mode with the UBUV filter set, or with the objective prism and no filters. The rest of the time is open to projects like the Survey for low luminosity Hx emission-line galaxies (UCM - CIDA), Variability Survey near the Galactic Plane (Yale, CFA, CIDA, Indiana), Catálogo Astrométrico y movimientos para el área de la "Carte du Ciel" zona San Fernando (CIDA - ROA), Solar System Science (ULA - Yale).

Key Words: **CCD MOSAIC CAMERA — DARK MATTER — QUASAR SURVEY**

1. GENERAL DESCRIPTION

The Quasar Equatorial Survey Team (QUEST) is a collaboration formed to carry out a systematic gravitational lensing study near the celestial equator. Researchers from Physics and Astronomy Departments of Yale University -USA-, Indiana University -USA-, Centro de Investigaciones de Astronomia (CIDA) -Venezuela- and Universidad de los Andes -Venezuela- with C. Baltay, G. Oemler and G. Bruzual serving as spokesmen, are working in order to pursue the following scientific goals:

1. a search for Dark Matter,
2. a measurement of Hubble's Constant using measurements of time delays in multiple imaged quasars and,
3. a test of cosmological models and a possible measurement of Einstein's Cosmological Constant by measuring the source redshift dependence of the gravitational lensing probability and the time evolution of Hubble's Constant.

The CIDA Schmidt Camera (1 m) at Mérida, Venezuela, and three additional telescopes namely the WIYN (3.5 m) at Kitt Peak, the Yale (1 m) telescope at CTIO in Chile and the CIDA reflector telescope (1 m) in Venezuela are used in order to find lensed quasars, since gravitational lensing at cosmological distances provides a uniquely powerful tool for pursuing the goals appointed above.

The project make use of the f/3 CIDA Schmidt telescope and the new 16 CCDs mosaic camera installed in it, to survey a large number of quasars, in a systematic form, around the celestial equator, from $+7$ to -7 degrees of declination, making use of the drift scanning techniques. In a second fase a new 96 CCD's mosaic will be installed to scan from $+25$ to -25 degrees of declination.

The camera consists of 16 CCDs, 2048×2048 pixels each, arranged in a 4×4 chip format. Pixels are 15 microns square, resulting in a scale factor of $1''$ per pixel, given the Schmidt telescope's focal length. Each set of four CCDs is mounted onto one finger. The four fingers are moved by cams to change the chip orientation, so they can be set perpendicular to the stars' motion, and, at the same time, to cool the CCDs to about $-67°$ C by a recirculating line that forces FLUTEC liquid behind the chips, previously cooled by a refrigerator located near the telescope. The camera housing is closed by a Fused Silica flattener lens that seals the dewar and serves as the optical window. Several filter sets are available, for drift scan and point-and-track modes.

The electronic system readout consist of a digital and an anolog board, responsible for the clocking and readout of a single CCD, that means we have 32 electronic boards for all CCDs. In addition to this two boards, the complete readout system includes a line clock generator and an interface card to the data acquisition computer. There are four pentium-based computers, one computer to readout one column off CCDs (east-west direction). The system is cooled by a commercial closed loop refrigerator to a temperature below $-80°$ C.

In Drifscan mode, each column of CCDs, corresponds to a CCD at a common declination, requires a common line start clock, while different columns require slightly different line start rates, dictated by the declinations bands being viewed.

Control of the detector operating mode is accomplished through a serial interface between the interface card and the digital boards. This mode allows the selective readout of an individual CCD, selection of drifscan or snapshot mode, and reset and calibration of all control systems.

Plus the four base computers, there are 2 computers for data storage (all of them with QNX operating system), one computer for master control and user interface (linux system) and one computer to connect with the outside world, give us a seven computer system.

The data is stored during the night on disk and could be written down to DLT tape (15 Gbytes compressed) or DAT(2/4 Gbytes). In the drift scan mode, this camera produces about 0.1 GB of data every 2 minutes.

The drift scanning method has several advantages over conventional point-and-stare imaging techniques, and thanks to the particular design, CCDs are distributed over 4 differents fingers. SInce each one looks at a slightly different declination during drift scanning, it is possible to obtain three or four color survey during the same observation using three or four different filters each one placed over a different finger.

The drift scanning place several limitations on the detector design, as the effective exposure time, the sidereal rate (function of declination) and the declination range that can be scanned.

The survey consists of two drift scans of the equatorial sky. The first scan will obtain direct imaging in three colors, the photometric survey. The other scan will be performed using the objetive prism, resulting in a spectroscopic survey.

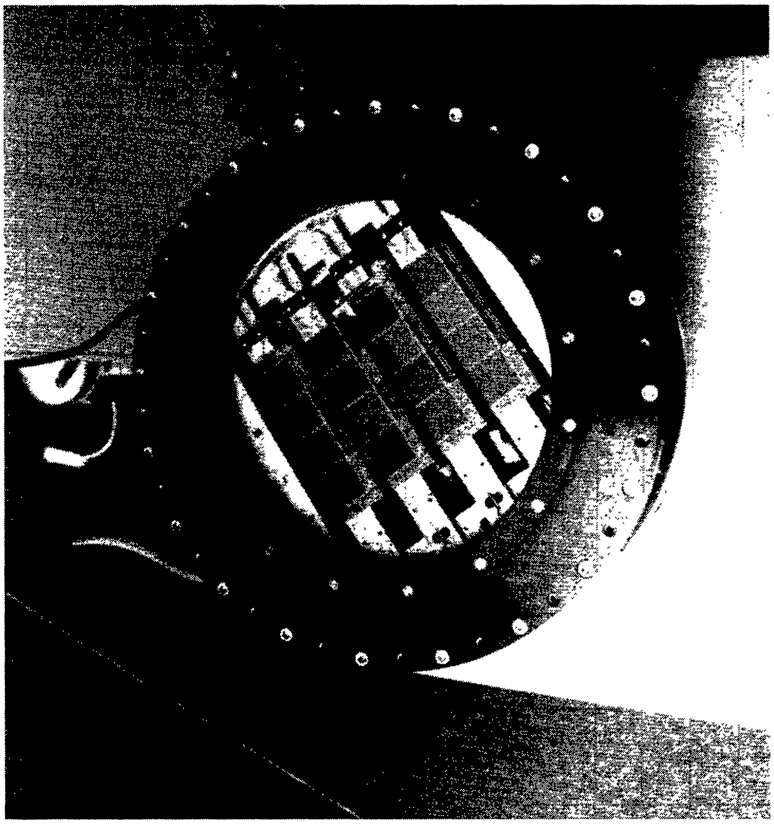

Fig. 1. Front view of the array showing the 16 CCDs onto the four movable fingers. The optical window is actually the fused silica flattener lens.

For the photometric survey, chips placed over two of the four finger observe the sky in the U bandpass, while chips on the other two fingers observe in the B and V bandpass respectibily.

Quasar identification is obtained by means of colour-colour diagrams. The caracteristic colours of quasars are well separated from virtually all other objects in the sky up to a quasar redshift of $z = 2.2$. For $z = 2.2$ or $z > 2.2$, they overlap with main sequence or white dwarf stars.

The spectroscopic survey is very effective in identifying high redshift quasars by virtue of the very prominent emission lines in quasar spectra. The most prominent emision line in quasar spectra is the Hydrogen $Lyman-\alpha$ line at 1216 Å. At a redshift of $z = 2.2$, this line is redshifted to 3900 Å, well into the region of good sensitivity of our detector. The maximum z that can be observed is limited by the lowpass filter used to exclude red photons. A 7000 Å cutoff filter has been choosen, which will allow $Lyman - \alpha$ to be visible for $z < 4.3$.

The WIYN telescope will be used to resolve the structure of compact gravitational lenses and a sensitive search for the lensing galaxy, so that the absence of a visible lens has a high probability of being dark matter.

The Yale (1 m) and the CIDA (1 m) telescopes will be used for monitoring the time variability of a large number of lensed quasars for time delay and Hubble constant measurement. The system has been working since early 1997. Even thought it is still under the calibration and debugging phase, under commisioning, an important quantity of astronomical data have been acquired. Half of the dark time is assigned to the QUEST project, observing in drift-scan mode with the UBUV filter set, or with the objective prism and no filters. The rest of the time is open to projects that need to use the camera. Some of these projects are: the Survey for low luminosity Hx emission-line galaxies (UCM - CIDA), Variability Survey near the Galactic Plane (Yale, CFA, CIDA, Indiana), Catálogo Astrométrico y movimientos para el área de la "Carte du Ciel" zona San Fernando (CIDA - ROA), Solar System Science (ULA - Yale).

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