ASTRONOMICAL PERFORMANCES OF THE MEPSICRON, A NEW LARGE AREA IMAGING PHOTON COUNTER

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The new detector MEPSICRON (microchannel electron position sensor with time resolution) is an image photomultiplier sensor for high spatial and time resolution, working in a photon counting regime. It has been especially designed for deep sky photometric pictures, for high resolution spectrophotometry with single or crossed dispersion spectrographs for long slit spectroscopic techniques, for high time resolution pictures and spectrophotometry especially related with speckles techniques and very fast varying sources as pulsars, and for Fabry-Pérot interferometry.

The first prototype of the MEPSICRON for astronomical use has been manufactured with a multialkaly photocathode of 25 mm diameter sensitive area (the design has been published in previous papers, Firmani et al. 1982 and 1983). The detector can be described as having three main parts: a proximity focused photocathode deposited on a quartz faceplate, an assembly of five high current 40:1 microchannel plates mounted in two stages with a V and Z configuration respectively, and a distortion free resistive anode.

A photoelectron produced by the incidence of a photon on the photocathode is accelerated toward the microchannel plates assembly where one electronic cascade with a gain of 10^8 electrons/count and very low statistical fluctuations is triggered. The electron cloud produced by the cascade is received by the distorsion free resistive anode that provides the partition of the total charge in four output pulses; the heights of these pulses are correlated with the position of the cloud centroid, i.e., the incidence point of the photon on the photocathode. The image processing system that recovers from the four output pulses of the detector the values of the x, y and t coordinates for each count, is based mainly on a pulse position analizer. The spatial resolution of 40μm and 52μm FWHM in the red and in the blue respectively, is uniform on the entire sensitive area. One array of 1024 by 1024 pixels provides a reasonable sampling of the image compatible with this resolution. The uncertainty of the photon arrival time is .2μs, however, the time coordinate is recorded with a precision of .1 ms which is sufficient for the

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majority of the purposes.

The average contribution of the dark current is 50 counts/sec on the entire sensitive area, or 1 count/pixel every 5 hours, with the detector cooled at -30°C. The low level of the noise of the dark count rate makes this detector very close to one which is photocathode quantum noise limited.

The maximum count rate for diffuse sources is 5×10^5 counts/sec; this limit is introduced by the electronic image processing system. The count rate for point images is limited by the recovery time of the microchannel plates;the statistical properties of the electronic cascade and consequently the spatial resolution begins to degradate above 50 counts/ sec pixel. The geometrical stability of the pixels array has been carefully considered at the level of the electronic design and 1 pixel on several days represents an upper limit of the geometrical shift on the entire frame. Preliminary tests of the pixel to pixel sensitivity variations give results better than 5%; more accurate tests will be performed in the future. The dynamic range of the MEPSICRON is extremely high due to the high count rate for point images and the low contribution of the dark current; their ratio gives a rough estimate of the dynamic range greater than 10^6. During one exposure the image is integrated on a 2 M bytes digital memory with 16 bits/pixel introducing, in practice, the main limitation on the dynamic range. A real time imaging on a color screen is provided during the exposure, as well as a photon coordinate record on magnetic tape. A Nova 1200 computer interacts with the 2 M bytes memory and controls the input/output on the magnetic tape and disk units.

For astronomical use the MEPSICRON has been mostly coupled with the REOSC echelle spectrograph at the 2-meter telescope of the Mexico National Observatory at Baja California. The dispersion obtained is .14 A/pixel (blue) and .25 A/pixel (red) and the resolution .3 A FWHM (blue) and .4 A FWHM (red), compatible with a slit wideness less than 2 arc seconds. An exposure time of one hour is required to obtain a spectrum in the blue, with a signal to noise ratio ≃10 for a 16 magnitude star.

The spectrum of the galaxy MK35 obtained in the blue region with a 900 groves/mm echelette grating is shown in Figure 1; the exposure time was 10 minutes and the spectrograph entrance slit width 10 arc sec. The first strong emission line that appears from the bottom is Hγ, while the first emission feature from the top is the [O II]λλ3726-9 doublet. A full resolution image of this doublet, in the same spectrum,is shown in Figure 2, where each pixel is visible as a small rectangle. Although the lines width is mainly due to the intrinsic velocity field of the galaxy, the two lines with 2.7 A of separation are completely resolved.

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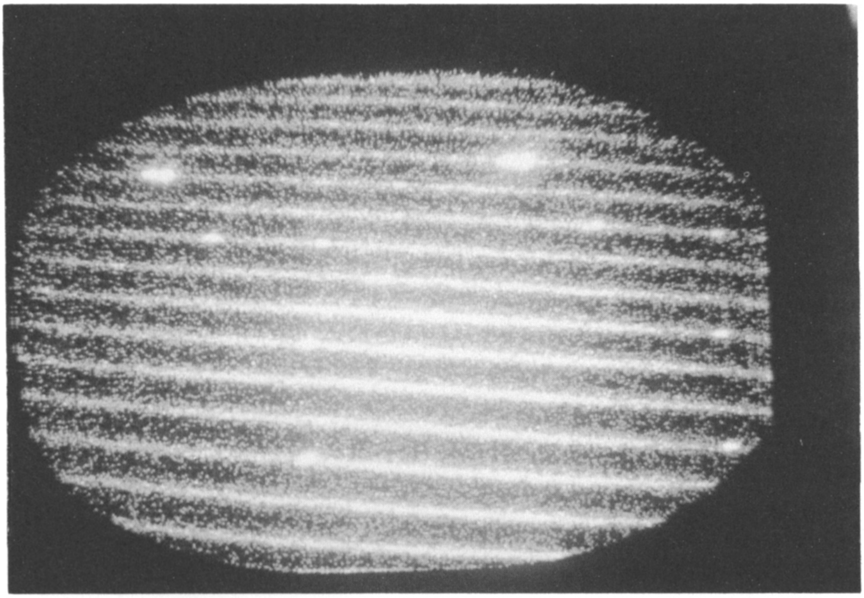

Fig. 1. The blue spectrum of the galaxy MK35

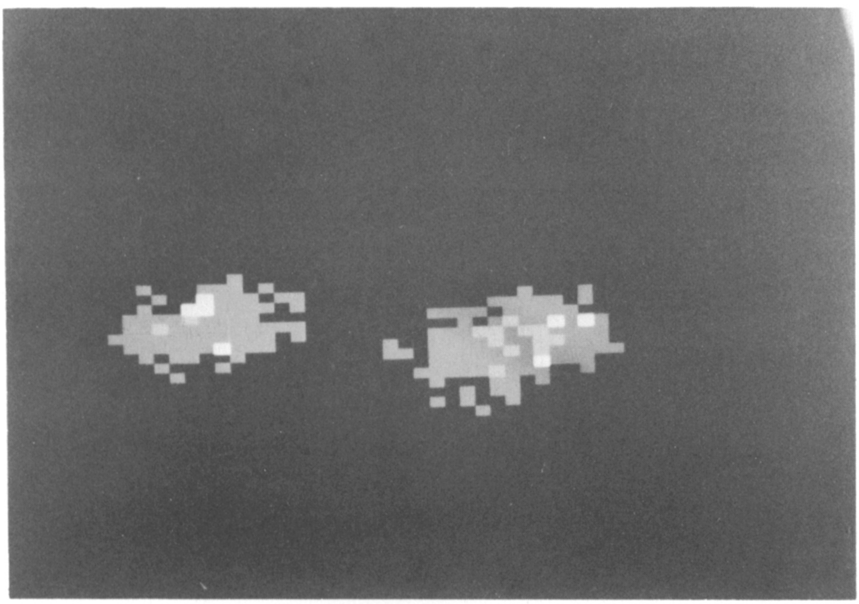

Fig. 2. Full resolution image of the |O II|λλ3726-9 doublet visible in Figure 1.

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The spectrum of the 14.5 photographic magnitude, M4.5V star, Ross 368, is shown in Figure 3; the exposure time was 30 minutes. The spectrum has been obtained with a 200 groves/mm echelette grating working at the first order in the red (top) and at the second order in the blue (bottom).

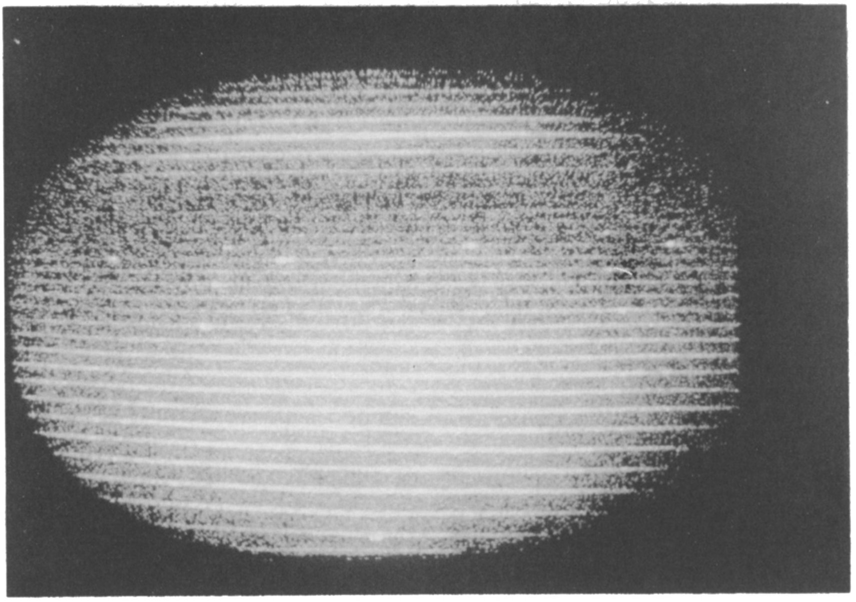

Fig. 3. The red (top) and blue (bottom) spectrum of the M4.5V star,Ross 368.

On the first order from the bottom, the [O I]λ5577 sky emission line is visible, while in the 17th and 18th order from the bottom, the K-CaII (left) and the H-CaII (right) emission lines are visible; this last line is near to and separated from Hε. The Balmer serie, in emission appears in the 7th (Hβ), 12th (Hγ), 15th (Hδ) order from the bottom. The strong emission feature in the red is Hα.

A large number of absorption lines have been identified (L. Carrasco and A. Serrano) showing the very complicated atmosphere structure of this type of stars.

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