中国科学院
紫金山天文台
Purple Mountain Observatory
Chinese Academy of Sciences

学术报告

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题　目：

State of the art IR cameras for wavefront sensing using e-APD MCT arrays

报告人：

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The success of the next generation of instrument for large (up to 10 m) or extremely larges telescopes (up to 40 m) in the visible-infrared will depend on the ability of Adaptive Optics (AO) systems to provide excellent image quality and stability. This will be achieved by increasing the sampling and correction of the wave front error in both spatial and time domains. For example, advanced Shack Hartmann systems currently fabricated require 40x40 sub-apertures at sampling rates of 1-1.5 kHz as opposed to 14x14 sub-apertures at 500 Hz of previous AO systems. Beyond the e2v CCD50 developed for the ESO NACO instrument in the late nineties, new detectors of 240x240 pixels are required to provide the spatial dynamics of 5-6 pixels per sub-aperture. Higher temporal-spatial sampling implies fewer photons per pixel therefore the need for much lower read noise (<<1e-) and negligible dark current (<< 1e-/pixel/frame) to detect and centroid on a small number of photons. This detector development was jointly funded by ESO and the OPTICON European network in the Joint Research Activity JRA2, “Fast Detectors for Adaptive Optic". e2v technologies was chosen in 2005 to develop a dedicated detector based on an extension of their L3Vision EMCCD technology. Analysis showed that the sub-electron read noise of L3Vision CCDs clearly outperformed classical CCDs even though L3Vision devices exhibit the excess noise factor F of 21/2 typical of EMCCDs.

During these years, a revolution appeared for infrared HgCdTe avalanche photodiodes detector arrays providing outstanding sensitivity and speed at the same time.

Developed by First Light Imaging and based on the Saphira detector developed by Selex for ESO, the C-RED infrared camera is opening a new era in terms of sensitivity and speed in the SWIR scientific cameras domain and is particularly suited for infrared wavefront sensing in complex AO systems like MCAO. Developed by First Light Imaging and based on the Saphira detector developed by Selex for ESO, the C-RED infrared camera is opening a new era in terms of sensitivity and speed in the SWIR scientific cameras domain and is particularly suited for infrared wavefront sensing in complex AO systems like MCAO.This is in strong contrast to what is observed in APDs made out of III-V material or Si, which requires high inverse bias and have typical noise factors of F~4-5 for III-V semi-conductors and F~2-3 for Si respectively. These exceptional characteristics of HgCdTe APDs are due to a nearly exclusive impaction ionization of the electrons, why these devices have been called electrons avalanche photodiodes, e-APDs. These results have inspired a large effort in developing focal plan arrays using HgCdTe APDs for low photon number applications such as active imaging in the range gated mode (2D) and/or with direct time of flight detection (TOF) (3D) and, more recently, passive imaging for infrared wave front correction and fringe tracking in astronomical observations. C-RED is using the SAPHIRA 320x256 2.5 microns cut-off 24 microns pixel pitch HgCdTe e-APD array allowing to obtain sub-electron readout noise, taking advantage of the APD noise-free multiplication gain and non destructive readout ability.

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