Quantum Well Infrared Photodetector (QWIP) Focal Plan Arrays for Astronomy

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Quantum Well Infrared Photodetectors (QWIPs) afford greater flexibility than the usual extrinsically doped semiconductor IR detectors because the wavelength of the peak response and cutoff can be continuously tailored over a range wide enough to enable light detection at any wavelength range between 6-20 μm. The spectral band width of these detectors can be tuned from narrow ($\Delta\lambda/\lambda \sim 10$ %) to wide ($\Delta\lambda/\lambda \sim 40$ %) allowing various applications. Also, QWIP device parameters can be optimized to achieve extremely high performances at lower operating temperatures (~ 40 K) for low background long-wavelength infrared applications in strategic arena as well as in Astronomy. Furthermore, QWIPs offer low cost per pixel and highly uniform large format focal plane arrays (FPAs) mainly due to mature GaAs/AlGaAs growth and processing technologies. The other advantages of GaAs/AlGaAs based QWIPs are higher yield, lower 1/f noise and radiation hardness. Recently, we operated an infrared camera with a 256x256 QWIP array sensitive at 8.5um at the prime focus of the 5-m Hale telescope, obtaining the images. The remarkable noise stability – and low 1/f noise – of QWIP focal plane arrays enable camera to operate by modulating the optical signal with a nod period up to 100 s. A 500 s observation on dark sky renders a flat image with little indication of the low spatial frequency structures associated with imperfect sky subtraction or detector drifts. To our knowledge, this represents both the first 256 x 256 mid-infrared imager and the first successful example of a ground-based instrument using slow-nod modulation at mid-infrared wavelengths.

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