

The first 10 kpix MKID array for DARKNESS

MKIDs for Direct Imaging of Exoplanets



Paper links on our website!
www.physics.ucsb.edu/~bmazin

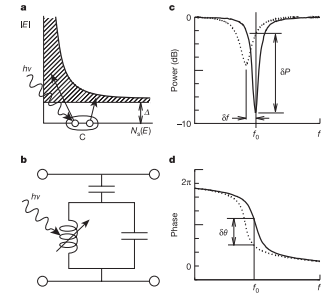
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Microwave Kinetic Inductance Detectors (MKIDs)

Microwave Kinetic Inductance Detectors (MKIDs) are a new cryogenic technology for UV, optical, and near-IR astronomy.

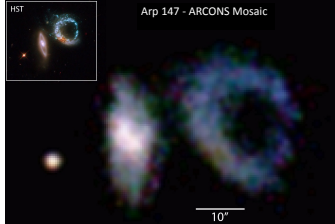
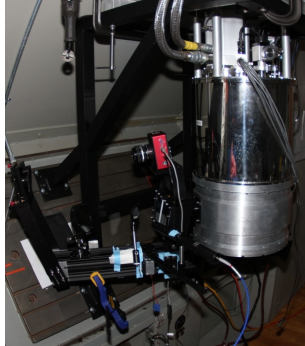


Advantages

- Energy resolution in each pixel
- Microsecond time resolution
- No read noise
- No dark current

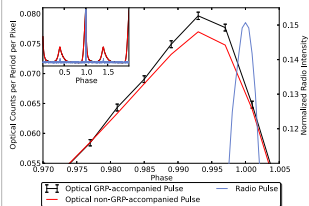
a) Photons produce quasiparticles in a superconducting film
b) Film is placed in a resonant circuit
c) and d) The change in amplitude and phase of a microwave probe signal measures the photon's energy (figures from Day *et al.* Nature, 425, 817, 2003)

ARCONS - The World's First Optical MKID Camera



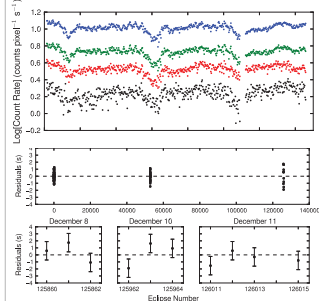
- 29 nights at Palomar and Lick Observatory
- 2024 pixels
- $\lambda = 400\text{--}1100\text{nm}$
- $R = E/\Delta E \approx 8$ at 450nm
- Zero read noise and dark current
- Mazin *et al.*, PASP, 123, 933 (2013)

Enhanced Optical Emission during Crab Pulsar GRPs:



Optical pulses that accompany Giant Radio Pulses (GRPs) are found to have a 3% enhancement over typical pulses, but for GRPs that are truly coincident in time with the optical pulses, a 10% enhancement is seen.
Strader *et al.* ApJ 779, L12, 2013

Orbital Expansion of SDSS-J0926, an Eclipsing AM CVn:



Eclipse timing over a six year baseline matches a quadratic ephemeris, with a positive period change, suggesting orbital expansion due to mass transfer.
Szypryt *et al.* MNRAS, 438, 3, 2014

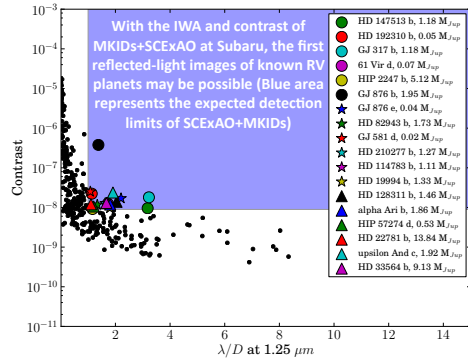
Dark Speckle Imaging

Mapping the time-varying dark speckle pattern generates a dark map with companions appearing as bright spots

- Temporal resolution faster than speckle lifetime
- Spatial resolution smaller than speckle size
- Low read noise and dark current

These are inherent features of MKIDS!

Focal Plane Speckle Nulling



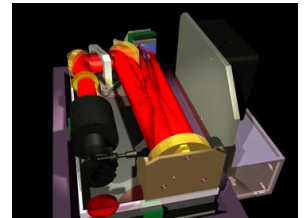
MKIDS will allow real-time measurement and control of focal plane coherent light with the speed and sensitivity required to track ~second lifetime atmospheric speckles

DARKNESS – An MKID IFU for Palomar

The DARK-speckle Near-infrared Energy-resolving Superconducting Spectrophotometer (DARKNESS) is an NSF funded MKID camera, planned for operation with the P1640 coronagraph and Stellar Double Coronagraph.

Instrument Parameters:

- Commissioning on the Palomar 200" in Fall 2015
- 10,000 pixels
- $\lambda = 800\text{--}1400\text{nm}$
- $R = E/\Delta E \approx 20$ at $1\mu\text{m}$ (goal)



Top: P1640: Apodized-pupil coronagraphy (AMNH)
Bottom: Simulated DARKNESS+P1640 J-band Contrast

