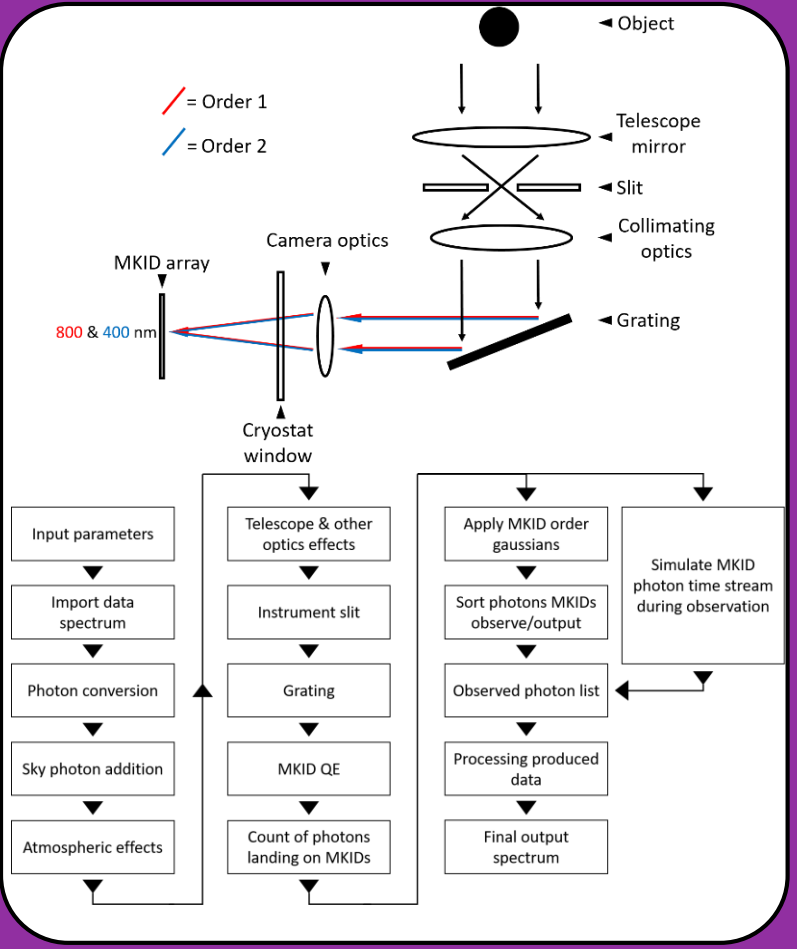
KIDSpec, a µs time resolving Microwave Kinetic Inductance Detector spectrograph for the optical/NIR

- **Utilises Microwave Kinetic Inductance Detectors** (MKIDs), which are novel superconducting detectors
- **KIDSpec will have a bandpass** of 0.3 – 2.5 µm and spatial capabilities, using 2 spectral arms
- **KIDSpec presents benefits for many science cases** including transients and faint source spectroscopy, due to the MKID's lack of read noise and dark current, and their µs time resolution
- **MKID's native energy resolution** allows them to separate incoming orders, so no cross-disperser is required simplifying the optical layout
- **The KIDSpec Simulator (KSIM)** can simulate KIDSpec's potential performance on sky, general overview shown in the bottom right panel



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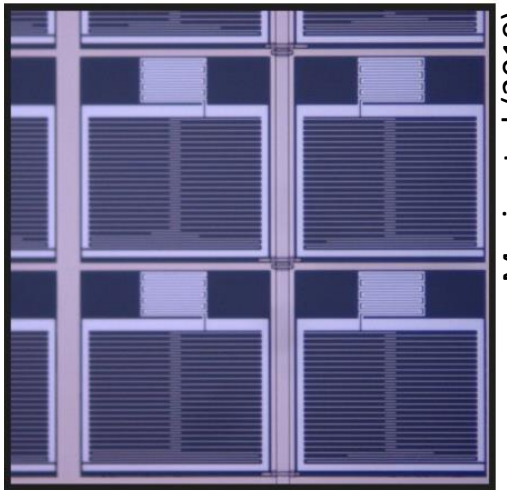
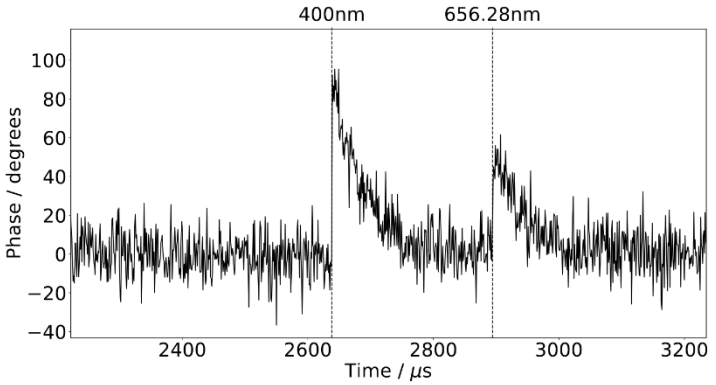
Microwave Kinetic Inductance Detectors (MKIDs)

- **Consists of** a capacitor and inductor to make a resonant circuit (top right), where incoming photons generate quasiparticles
- **A microwave signal is passed through the MKID**, to detect changes in its phase and amplitude as a result of these quasiparticles
- **In a phase time stream** (bottom right) incoming photon events appear as a fast rise, the time of which can be resolved on the order of µs
- **The height of the fast rise** is due to the energy of the incoming photon with higher energies generating more quasiparticles which causes a greater phase change
- **The MKID can separate** orders of light from a grating itself, not needing a cross disperser



Mazin et al (2019)



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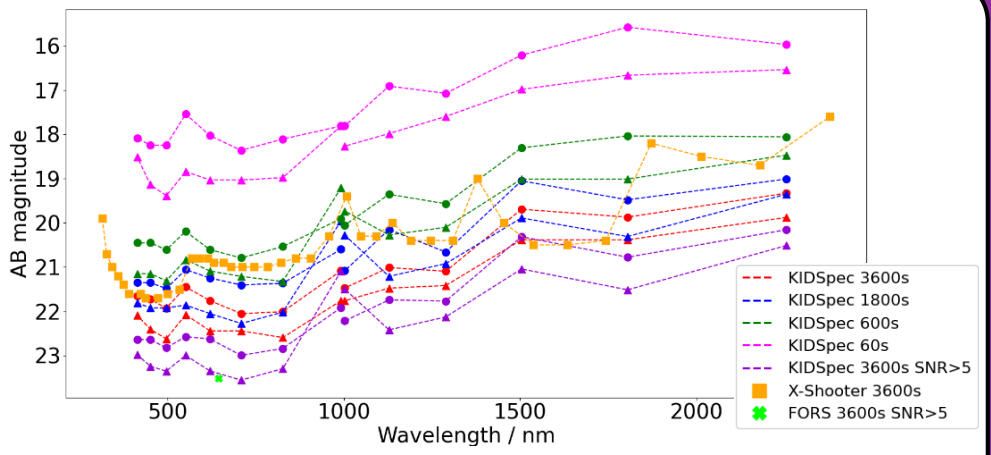
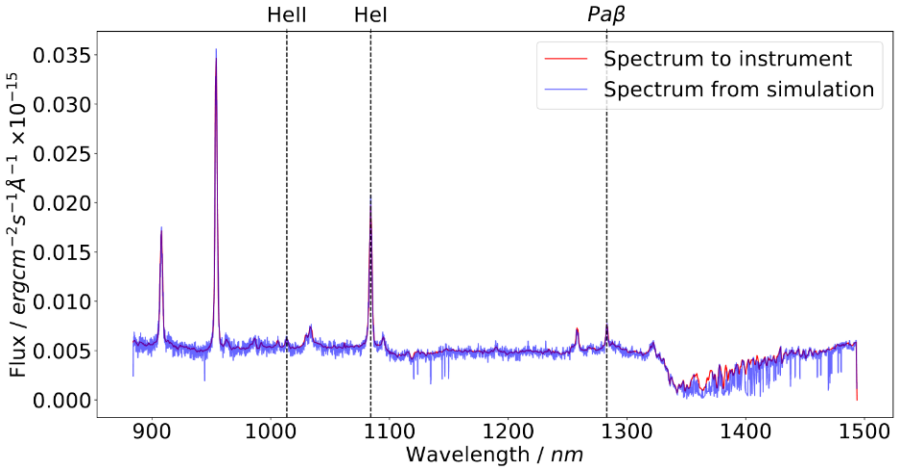
KIDSpec's limiting magnitudes and faint source potential



- **KIDSpec (using 2x2500 MKIDs) limiting magnitudes for two outputs, unbinned (●) and binned (▲) to a spectral R≈2600**
- No read noise grants flexible rebinning
- Simulated for SNR>10 on a 4m telescope
- KIDSpec remains at worst comparable to instruments with similar science cases (X-Shooter and FORS) while being able to grant both instrument's spectral resolutions



- **Spectrum of Mrk348 at M_R=21 with 2500 MKIDs in each spectral arm**
- Simulated for a 900s on a 8m telescope
- Average residuals of (4.6±2.8)%, R value of 0.964, and misidentified photon % of 0.09%
- Average SNR (SNR_{av}) of 4.53, almost double when compared to X-Shooter's SNR result (including its CCD noise) which was 2.76

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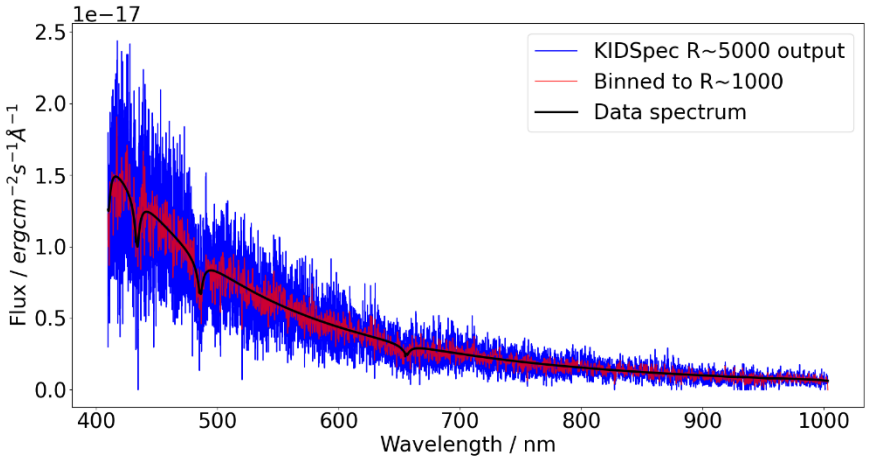
Short period binary system ZTF J1539 + 5027



- **Binary system similar to ZTF J1539 + 5027, with M_V = 22, for 200s on 10m telescope**
- Using 2500 MKIDs in each spectral arm
- SNR_{av} of 0.91, and 0.20 and 0.33 for X-Shooter and SOXS respectively
- Using KIDSpec's flexible rebinning potential, spectrum rebinned to spectral R≈1000 with SNR_{av}≈4.72
- The velocity semi-amplitude of ZTF J1539 + 5027, from Burdge et al (2019) carry large errors due to the short period of ≈7 minutes
- KIDSpec with MKIDs can deliver time resolved, read noise free spectra which will be able to better constrain these parameters by allowing for more phase bins

Conclusions

- KIDSpec presents exciting opportunities for many science areas especially using its time resolving and low noise capabilities
- While KIDSpec is being designed using KSIM, its science case list continues to grow
- To simulate or discuss a science case using KSIM, please contact the author of this poster

References

- Page 1: O'Brien (2020)
- Page 2: Day et al (2003), Mazin et al (2019), Meeker et al (2015)
- Page 3: Data for Mrk348 shared by Dr. C. Ramos Almeida (Ramos Almeida et al. 2009), Kaper et al. (2008), Schipani et al. (2018).
- Page 4: Binary system simulated using TLUSTY software (Hubeny 1988), Burdge et al (2019)

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