Observation and control of stray light coupling inside lens-antenna coupled microwave kinetic inductance detector arrays

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Control of the origin of detected radiation is one of the key parameters for successful instrument performance. Ideally, the additional "stray" light power should be kept as a small fraction of the power of the source of interest. Here we identify a stray light source due to radiation scattering inside the detector carrier wafer and lens array assembly of lens-antenna coupled microwave kinetic inductance detector (MKID) arrays. This scattered radiation is then absorbed away from the initial incident MKID, leading to a low-level optical crosstalk or low angle stray light. For an imaging lens-antenna coupled MKID array, we observe that this manifests as a "pedestal" or "error beam" superimposed on the beam pattern. While the level of this pedestal is very low at any one position (<<-25dB), it is however spread out over the entire detector chip. In the presented array, the integral of the power in the pedestal becomes significant fraction of up to ~40% that detected. This effect leads to complications in optical calibration, while the stray loading suppresses the MKID internal Q factor and more importantly add additional photon noise so deteriorating the sensitivity. Similar effects have been observed in on chip MKID filter-bank spectrometers, showing the wider relevance of this effect. We present measurements of the pedestal and show how it can be controlled using an on-chip radiation absorber.