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Extremal approximations in the bandlimit and the Rayleigh criterion for super-resolution

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Of particular interest in imaging sciences and telecommunications is the super-resolution problem, which consists in recovering a stream of spikes (point sources) from the noisy observation of a few number of its first trigonometric moments weighted by the ones of the point-spread function (PSF). The empirical feasibility of this problem has been known since the work of Rayleigh on diffraction to be essentially driven by the separation between the spikes to recover.

We present a novel statistical framework based on the spectrum of the Fisher information matrix (FIM) to quantify the stability limit of super-resolution as a function of the PSF. In the regime where the minimal separation is inversely proportional to the number of acquired moments, we show the existence of a separation constant above which the minimal eigenvalue of the FIM is not asymptotically vanishing—defining a statistical resolution limit. Notably, a relationship between the total variation of the autocorrelation function of the PSF and its association resolution limit is highlighted.

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