EXTREME TWINKLING, AND ITS OPPOSITE

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Motivated by the existence of astrophysical refracting and diffracting media of many different types (e.g. gravitating masses), with a vast range of scales, I survey the extreme regimes of electromagnetic wave propagation by describing the singularities of light [1, 2]. In the geometrical-optics limit, rays concentrate on caustics [3]. These are the singularities of bright light. Caustics (of imaginary light emitted by telescopes) are the key to understanding gravitational lensing of point and extended objects (caustic-touching theorem [4]). Diffraction softens the intensity singularities, and generates fringes, in ways described by universal wavelength scaling exponents determined by the catastrophe classification of singularities [5]. For random waves, these exponents compete and combine into scaling laws for the moments of the intensity fluctuations. This is extreme twinkling. Opposite to caustics are the zeros of wave fields, which are dislocation lines of the phase of light [6]. These are the singularities of faint light. Dislocations are extraordinarily sensitive to parameters: in model calculations [7], the phase landscape can change its topology if a dimension in a field is varied by a thousandth of a wavelength. Dislocations and caustics are complementary singularities. In addition, there are singularities of the pattern of polarization; these are the disclinations [8], and lines of circular polarization [9], of the vector field of light [10].

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