CC/NUMBER 7
FEBRUARY 18, 1980

This Week's Citation Classic

Fried D L. Optical resolution through a randomly inhomogeneous medium for very long and very short exposures. *J. Opt. Soc. Amer.* **56**:1372-9, 1966. [Electro-Optical Lab., Autonetics, Div. North Amer. Aviation, Anaheim, CA]

Atmospheric turbulence induced wavefront distortion limits imaging system resolution. For very small/large aperture diameters resolution varies as diameter squared/is constant. The knee of the resolution versus diameter curve is at diameter = r_o, called the 'coherence diameter.' By itself, r_0 adequately measures the effect of turbulence on propagation. [The *SCI*® indicates that this paper has been cited over 145 times since 1966.]

David L Fried
Optical Sciences Company
P.O. Box 446
Placentia, CA 92670

September 24, 1979

"Starting in 1963, anticipating future developments in the application of lasers, I became interested in the problem of laser beam propagation through atmospheric turbulence, and in related optical propagation effects. Consequently, I started a program of analysis which in fairly short order led to the results presented in the subject paper, as well as in several others. The two most significant and the most closely related of these others are 'Statistics of a Geometric Interpretation of Wavefront Distortion' and 'Optical Heterodyne Detection of an Atmospherically Distorted Signal Wave Front.'[1,2] The central feature of each of these papers was the same —the identification of a quantity with the dimensions of length, which I denoted by the notation r_o, and which I call the 'coherence diameter.' \n my work, I was able to show that this single quantity provides a measure of the atmospheric turbulence imposed limit to the effective aperture diameter of a coherent optical system. If it is smaller (or larger) than the system's aperture diameter, then turbulence effects on system performance are substantial (or negligible). The quantity r_o serves as a measure of the extent of wavefront distortion —the smaller it is, the more severe the wavefront distortion. The subject paper, along with the other two, explored the implications of the size of r_o for various types *of* optical systems.

"After my initial completion of this work, I prepared an informal report and put the work aside for about a half year. At the end of this time, I was able to return to this work with a fresh view *of* the analysis and of how to interpret the results —which greatly helped me in reducing the results to their essential features. I believe that the opportunity provided by this interval to mull over the results before presenting them contributed significantly to their subsequent general acceptance. I then prepared the subject paper, as well as the other two mentioned above.

"The sequence of preparation *of* the papers corresponds to the fact that I intended the heterodyne detection paper to appear first and introduce the quantity, r_o, with the other papers referencing that publication. Because of 'problems' with reviewers (which actually contributed quite constructively to the final form of that paper), the appearance of the heterodyne detection paper was considerably delayed. The geometric interpretation paper was the first to appear. This paper was apparently unable to convey the physical significance of r_o to the intended audience until much later with the eventual development *of* interest in adaptive optics. That task thus fell to the subject paper on image resolution, which apparently has been quite successful in accomplishing that mission.

"Although this paper is organized around the subject *of* resolution of conventional imaging systems, I believe that the reason it has been cited so often is because *of* its introduction *of* the coherence diameter, r_o. This quantity has proven to be a convenient parameter for organizing the results of measurements and of theoretical analyses *of* the effect of atmospheric turbulence on all sorts of coherent and quasi-coherent optical systems, both active and passive."

1. **Fried D L.** Statistics of a geometric interpretation of wavefront distortion. *J. Opt. Soc. Amer.* **55**:1427-35, 1965.
2. ·····. Optical heterodyne detection of an atmospherically distorted signal wave front *Proc. IEEE* **55**:57-67, 1967.