PROPAGATION OF RADIO WAVES IN THE SUN'S CORONA: ANGULAR BROADENING IN THE LIMIT OF SMALL-ANGLE SCATTERING

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Extended Abstract

In recent years, large numbers of high-resolution observations of a variety of solar radio emissions have been performed at centimeter and decimeter wavelengths. These have shown a striking absence of fine structure, even though there are observational and theoretical grounds for believing that such structure is present. Exploiting recent work on the nature of electron density fluctuations in the solar corona and solar wind, I have used the theory of wave propagation in random media to reassess the problem of scattering of radio waves in the solar corona in the limit of small-angle scattering. The spectrum of inhomogeneities in the electron density is parameterized as a power-law distribution with an inner scale. I show that the radio brightness distribution is subject to angular broadening. The functional form of the angular broadening function is Gaussian; the width of the "scattering disk", θ_g, is of the order required to account for the observed absence of fine structure at wavelengths longward of a few centimeters. The calculations further show that: i) θ_g increases, on average, from the center-to-limb of the solar disk at a given wavelength although considerable variation is possible from place-to-place; ii) if the level of the turbulence, $C_n^2(r)$, is truncated at some radius r_c, θ_g decreases with increasing r_c for a given wavelength. Furthermore, the center-to-limb variation of θ_g becomes flatter with increasing r_c; iii) the scattering angle becomes large for wavelengths longer than a few decimeters. Hence, the analysis employed here is invalid for radio emission longer than a few decimeters.

The possibility that speckle techniques might be of some use has been considered. It is found that the decorrelation bandwidth and decorrelation time are generally so small as to render radio telescopes insensitive in the speckle regime. I conclude that angular broadening due to inhomogeneities in the solar corona likely imposes a fundamental limitation on the degree of angular resolution with which one can map solar radio emissions, with the possible exception of compact and extremely bright sources, e.g., the millisecond spike bursts. A detailed treatment of the problem of scattering of radio waves in the solar corona is given by Bastian (1994).

References

1. Bastian, T.S. 1994, *Ap. J.*, 426, issue of May 10.