Constraints on coronal turbulence models from source sizes of noise storms at 327 MHz

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We seek to reconcile observations of small source sizes in the solar corona at 327 MHz with predictions of scattering models that incorporate refractive index effects, inner scale effects and a spherically diverging wavefront. We use an empirical prescription for C_N^2 based on VLBI observations by Spangler and coworkers, of compact radio sources against the solar wind between 10–50 $R_\odot$. We use a model for the inner scale by Coles & Harmon (1989) that presumes that it arises out of cyclotron damping. In view of the prevalent uncertainty in the power law index that characterizes solar wind turbulence at various heliocentric distances, we retain this index as a free parameter.

We explore various combinations, but find that the models generally underpredict the source size by an order of magnitude or more. We find that the use of a spherically diverging wavefront supresses the predicted source size substantially. We also find that inner scale effects reduce the predicted source size.

One interpretation of the result that the observed source size far exceeds the predicted one could be that the level of the turbulence amplitude C_N^2 is generally much smaller in the inner corona than what an interpolation of the empirical prescription would suggest. On the other hand, we note that all the observations of small sources in the corona are limited by the instrument resolution, and this result could imply that future observations with better resolution can detect much smaller sources.

Keywords: Coronal scattering; Radio wave propagation.

References

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