Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Wavenumber-frequency spectra in the logarithmic layer of wall turbulence[1] MICHAEL WILCZEK, RICHARD J.A.M. STEVENS, CHARLES MENEVEAU, Johns Hopkins University — We study space-time correlations of wall-bounded turbulence in terms of wavenumber-frequency spectra of the streamwise velocity component. The spectra are obtained from Large Eddy Simulations, which provide a full space-time record of the flow. We find that the frequency distributions exhibit a Doppler shift, which is a consequence of mean flow advection, as well as a considerable Doppler broadening, consistent with the Kraichnan-Tennekes random sweeping hypothesis. For wall-bounded turbulence, both of these effects vary with the wall distance and are closely related to the logarithmic behavior of the mean velocity profile and the velocity fluctuation profiles. We incorporate these observations into a simple analytical model for the wavenumber-frequency spectrum based on an advection equation featuring advection of the small-scale velocity fluctuations with a mean and a large-scale random-sweeping velocity. The model is found to be in very good agreement with the LES data. Potential applications of the model spectrum, e.g., to quantify the spatio-temporal structure of fluctuations in wind energy conversion, will be discussed.

[1]Supported by DFG grant WI 3544/2-1, "Fellowships for Young Energy Scientists' ' (YES!) of FOM, and the US National Science Foundation grant IIA 1243482.

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Date submitted: 30 Jul 2014 Electronic form version 1.4