Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Taylor's hypothesis in turbulent channel flow considered using a transport equation analysis[1] JAMES WALLACE, Univ. of Maryland, CHEN-HUI GENG, GUOWEI HE, Chinese Acad. of Sci., Inst. of Mech. (LNM), YIN-SHAN WANG, CHUNXIAO XU, Tsinghua Univ. — A DNS of turbulent channel flow was carried out to examine Taylor's "frozen turbulence" hypothesis, i.e. the simple time-space transformation that allows $(1/\overline{U})\partial/\partial t$ to approximate streamwise derivatives, $\partial/\partial x$, of velocity fluctuations. These terms in Taylor's hypothesis appear in the transport equation for instantaneous momentum for this flow. The additional terms, i.e. the additional convective acceleration and the pressure gradient and viscous force terms, act to diminish the validity of Taylor's hypothesis when they are relatively large compared to the Taylor's hypothesis terms and are not in balance. A similar analysis also has been applied to the transport equation for instantaneous vorticity. There the additional terms, namely the additional convective rates of change, the stretching/compression/rotation and the viscous diffusion of vorticity terms, similarly act to diminish the validity of Taylor's hypothesis when they also are relatively large compared to the terms in the hypothesis and are not in balance. Where in the channel flow this diminishment occurs, and to what degree, and which of the non-Taylor's hypothesis terms in the momentum and vorticity equations contribute most to this diminishment will be presented.

[1]Supported by National Natural Sci. Found. and the National Basic Res. Progr. of China and the Burgers Progr. for Fluid Dynamics.

James Wallace
University of Maryland

Date submitted: 21 Jul 2014