Abstract Submitted
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Theory of Relativistic Fluid Turbulence GREGORY EYINK, Johns Hopkins , THEODORE DRIVAS, Princeton — Relativistic turbulence is expected in high-energy astrophysical flows, e.g. AGN outflow jets. We obtain exact theory by space-time coarse-graining the fluid stress-energy tensor, giving the analogue of Reynolds stress. Kinetic energy cascade is not natural in relativity, but cascade of internal energy is found with scale-transfer due to contraction of the Reynolds stress-energy tensor with the 4-gradient of the coarse-grained 4-velocity. Unlike non-relativistic turbulence, where energy flux is Galilei-invariant, Lorentz invariance of relativistic cascade is broken at finite Reynolds number but restored in the infinite-Reynolds limit. Otherwise, our results closely parallel those on non-relativistic compressible turbulence, with (i) a new mechanism of turbulent energy dissipation due to "pressure-dilatation defect" exemplified by relativistic shocks and (ii) an inverse cascade of entropy with microscopic entropy production as source and large-scale cooling as sink. We obtain Kolmogorov 4/5th-type laws that give estimates on turbulent scaling exponents. When speed of light goes to infinity, our theory recovers non-relativistic results. The analysis provides the framework for relativistic LES modeling and extends Onsager's "dissipative Euler" theory to relativistic turbulence.

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