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Extreme Anomalous Particle Transport in the Random Linear Amplification Model of the Edge Plasma Turbulence.

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The anomalous, or strange character of the particle transport in random environment is characterised by the algebraic asymptotic behaviour of the mean values of powers of particle displacement $\mathbf{r}(t)$ versus time. In the most general case, the anomalous or strange character is encoded in the dependence on p of the exponents $\varsigma_p = \lim_{t\to\infty} \log\left[\left\langle |\mathbf{r}(t)|^p \right\rangle\right] / \log(t)$. In the normal case: $\varsigma_p = p/2$ [1]. The *extreme anomalous* particle transport studied in this work is characterised by an exponential divergence, in the limit of large times t, of the higher moments of the particle displacement. For $p > \beta \geq 0$, the asymptotic formula hold: $p - \beta = \lim_{t\to\infty} \log\left[\left\langle |\mathbf{r}(t)|^p \right\rangle\right] / t$, in other words for $p > \beta$ and large time t, we have: $\left\langle |\mathbf{r}(t)|^p \right\rangle \propto \exp[(p-\beta)t]$. We remark the contrast with usual anomalous case [1], where for large time t we have $\left\langle |\mathbf{r}(t)|^p \right\rangle \propto t^{\zeta_p}$.

This new result is demonstrated in the framework of the random linear amplification model described in [2], which was developed to explain the experimental results on the edge turbulence on DIII-D tokamak, from refs. [3-4]. The constant β is the power law decay exponent of the heavy tail of the cumulative probability distribution function of the intensity of electrostatic field fluctuations in the plasma edge [2].

From empirical approximate [4] or exact self-similarity arguments, it follows [2], that $0 < \beta << 1$, which is confirmed by tokamak edge plasma measurements [3] as well as by three fundamental self-organized criticality models [5]. It follows that all the integer moments of the particle displacement diverge exponentially, justifying the *"extreme anomalous"* terminology. We proved that the *extreme anomalous* particle transport qualitatively give rise to the correct, experimentally verified, isotope effect.

References.

1. R. Balescu, "*Statistical Dynamics: Matter out of Equilibrium*", Word Scientific (1997), "*Aspects of Anomalous Transport in Plasmas*", Taylor & Francis (2005).
2. G. Steinbrecher, B. Weyssow, Phys. Rev. Lett. **92**, 125003 (2004).
3. T. L. Rhodes et al, Phys. Lett. **A 253**, 181 (1999).
4. M. Gilmore, C.X. Yu, T.L. Rhodes, W.A. Peebles, Physics of Plasmas **9**, 1312-1317 (2002).
5. D. Turcotte, Rep. Progr. Phys. **62**, 1377 (1999) [see page 1379].