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Anomalous Diffusion: Experimental Results and Theoretical Challenges

Anomalous Diffusion – Fast Atoms and Fast Red Indians

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We started from fast diffusion of atoms in ordered alloys and found a couple of interesting systems where the diffusion of one of the components is surprisingly much faster than that of the other partner. With newly developed methods we were able to determine the elementary jump (see e.g. [1]), but whatever we tried, we could not detect a process which differs from the simplest case, i.e. atomic jumps to nearest neighbour sites. The diffusion process rather follows the conventional Fick's equation and the Einstein-Smoluchowski relation, i.e. the mean displacement x_{rms} grows with root of time. Reasons for the anomalies are rather phase transitions, soft lattice modes, and sometimes just unknown.

For describing diffusion and expansion of living beings an additional term has to be added in Fick's equation, namely the net growth rate of the species. The classical example for the dispersion of living beings, i.e. the spread of the muskrat introduced into Europe in 1905 [2], or the demic diffusion of the Neolithic farmers from the Near East into Europe [3], were well explained in terms of diffusion and growth, x_{rms} growing linearly with time (velocity of dispersion being constant). Some recently studied phenomena, however, do not follow this simple logics. We will report on at least two of such dispersion processes, the spread of the horse-chestnut leaf-miner [4] and the spread of the Paleoindians from Siberia into the Americas [5].

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