Anomalous Behavior of the Diffusion of Identical Particles, Divided in Two Sets that Scatter Simultaneously in Different, but Exchangeable, Energy States

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Resumo/Abstract:
It is introduced a theory that considers the behavior of a new class of diffusion phenomena. This new class considers two interdependent energy states. For the principal state the classical flux potential applies. For the secondary energy state a new flux potential was introduced which depends on the third derivative of the concentration with respect to the space variables. Consequently the particles are divided into two simultaneous fluxes. The secondary flux, derived from the new potential, is subsidiary to the principal flux in the sense that it exists if and only if the principal flux (Fickian flux) is activated. The new diffusion equation requires the introduction of two new parameters namely the flux distribution parameter, or flux partition β and a new physical constant that we call reactivity coefficient R. It is shown that the bi-flux approach represents delays or acceleration in the scattering process. Consequently it is possible two have in a given spatial domain, increasing density, rarefaction or stagnation depending on the inflow/outflow relationship. This flexibility to model the dynamics of motion allows for a better representation of the self-control ability of particles to commute between the principal flux and the secondary flux. This is particularly important for living materials and cells. It is clearly shown through the solution of the inverse problem that it is expected a relation of the form $\beta = F(R)$. This property is of crucial importance for anisotropic media. There is strong evidence that the parameter R plays the role of an attractor, meaning that the concentration increase on regions where R is large. Also as a consequence of the introduction of the second potential a fraction of the particles move towards regions where the curvature of the distribution increases. Particularly important, for special cases of anisotropy, is

the tendency to accumulate instead of dispersing with the flux following the opposite direction as expected from the Ficks law. This anomalous behavior can arise at the very beginning of the diffusion process. Another interesting result is the regularization that the proposed equation introduces in the non-linear version of the Fish-Kolmogorov equation.