

Atomic nuclei are complex mesoscopic systems with many (though finite) internal degrees of freedom. Nuclear collisions occur in isolation from all external environments, and although they sometimes result in scattering in a coherent superposition of discrete excited states of the outgoing nuclei, they also result in effectively irreversible processes (e.g. fusion or energy dissipation in deep-inelastic collisions). The irreversibility is understood to result from opening up of many nucleonic degrees of freedom, which play the role of the environment. The coherent time-independent coupled-channels model of scattering and fusion treats irreversibility through an imaginary potential. It has successfully described many aspects of nuclear collisions, including the directly measured eigenchannels of the system at the Coulomb barrier. However, recent measurements probing closer to the region of irreversibility (inside the barrier) show evidence for departures from the predictions, interpreted as showing the need to treat decoherence explicitly. Measurements of the properties of scattered nuclei show evidence for the nuclear processes that may act as doorways to decoherence and dissipation, and should guide the development of models which describe simultaneously coherent and irreversible outcomes.