Thermal effects on neutron capture cross sections using a quantum dynamical approach

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The neutron capture process plays a vital role in creating the heavy elements in the universe. The environments involved in these processes are, in general, high in temperature and are characterized by two distinct reaction mechanisms: the slow and rapid neutron capture processes. In this work, the slow neutron capture process is described with the time-dependent coupled channels wave-packet (TDCCWP) method that uses both a many-body nuclear potential and an initial temperature-dependent state to account for the thermal environment. To evaluate the role of a mixed and entangled initial state in the temperature-dependent neutron capture cross section, TDCCWP calculations are compared with those from the coupled-channels density matrix (CCDM) method based on the Lindblad equation. The importance of including temperature in the initialisation step is compared to a thermalisation of the capture cross section using a Hauser-Feshbach style approach. The stellar reaction rates are also compared between these models to compare effective Stellar Enhancement Factors.