Reaction rates with temperature dependent cross sections using quantum dynamical reaction theory in the (n,^{188}Os) reaction

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The neutron capture process plays a vital role in the creation of the heavy nuclei in the universe. The environments involved in these processes are in general high in temperature and are split into two different reaction mechanisms, the slow and rapid neutron capture regimes. Each of these is dependent on the temperature of the environment and the neutron density, where the slow neutron capture process takes place in the nucleosynthesis of stars and the rapid neutron capture process takes place in explosive astrophysical events. The temperature range of these environments is as low as 5 keV for the slow capture regime, and as high as 10 MeV for the fast capture regime. Here, the Time-Dependent Coupled Channels Wave-Packet (TDCCWP) method utilizes a quantum dynamical model with a many-body nuclear potential while also including these thermal effects in the initial state of the model. Static methods, such as CCFULL [Hagino, 1999], have previously been used for similar coupled channels calculations by solving the coupled channels equations of motion. However, the inclusion of these thermal effects in the calculation of neutron capture cross sections has not been explored. The differences in cross sections are compared to first check the validity of TDCCWP, a dynamic model, with CCFULL, a static model, excluding any thermal effects. The importance of the temperature of the environment, particularly at thermal energies larger than 0.1 MeV, is highlighted by the change in reaction rates when thermal effects are included in TDCWWP, as shown in the attached figure.

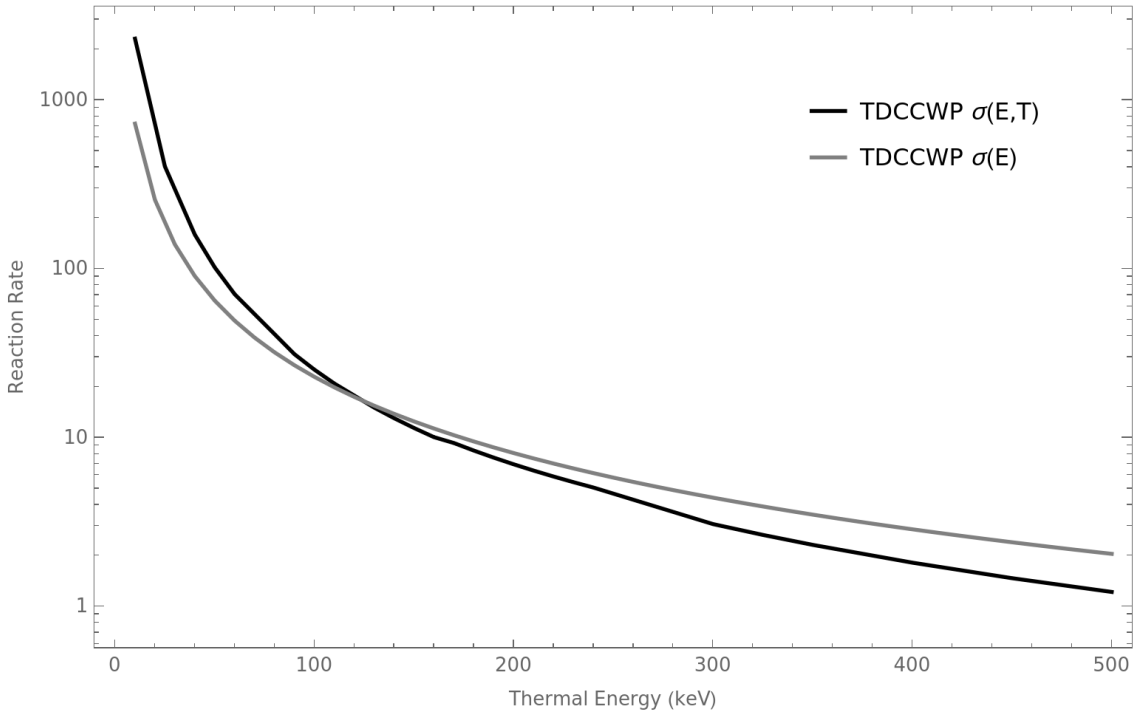

FIG. 1: A reaction rate calculation with and without temperature dependent cross sections are shown and the hint at the slow neutron capture dominance in the creation of this isotope is shown by the reaction rate increasing for smaller thermal energies and decreasing for larger thermal energies