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The Next Generation of Collisional Radiative Modelling for Tokamak Plasmas

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Collisional Radiative (CR) modelling has been of interest to the plasma physics community for decades, and provides a powerful tool for predicting the spectral emission and state population behaviour of plasmas in various regimes. The ITER project will require sophisticated CR codes to provide predictive capability across all modes of operation, as well as during periods of instability, especially during tokamak disruption events, wherein runaway electron populations can form and threaten the integrity of the tokamak machine. Herein we present a cursory summary of the motivation for development of robust CR models, provide a surface level summary of some of the physics included in contemporary codes, and provide simulations of ionic populations in relevant plasma regimes using one contemporary CR package, FLYCHK. We further explore the limitations present in these simulations, and examine where improvement is required in the next generation of CR models to provide sufficient predictive power for the ITER project. We conclude by providing recommendations for the inclusion of improved atomic and scattering data, semi-empirical models of Runaway Electron population formation, and the development of alternative models of the time-evolution of tokamak plasmas.