Element transport in evolutionary models: A new look at the spectral evolution of white dwarfs

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It is empirically well established that cooling white dwarfs experience radical changes in surface composition due to various physical processes, such as atomic diffusion, convective mixing, and stellar winds. This phenomenon, known as spectral evolution, remains poorly studied from a theoretical perspective, as it is notoriously challenging to model stellar evolution and element transport in a self-consistent way. In this talk, we present detailed simulations of the spectral evolution of white dwarfs performed with the Montréal evolutionary code STELUM, in which all relevant transport mechanisms are fully coupled to the cooling process. First, we investigate the transformation of a helium-rich DB star into a carbon-polluted DQ star through the dredge-up of settling carbon by the helium convection zone. We show that our models perfectly reproduce the trend of decreasing carbon abundance with decreasing effective temperature observed in DQ white dwarfs. We also demonstrate that the predicted abundances are extremely sensitive to a number of physical parameters, most notably the extent of convective overshoot, which can thus be constrained from the measured abundances. Second, we present the first self-consistent simulation of the conversion of a hydrogen-atmosphere DA star into a helium-atmosphere DC star through the convective mixing of the superficial hydrogen layer with the underlying helium envelope.