Structure and evolution of massive white dwarfs in general relativity

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Ultra-massive white dwarfs ($M > 1.10 M_{\odot}$) are of utmost importance in view of the role they play in type Ia supernovae explosions, merger events, the existence of high magnetic field, and the physical processes in the Super Asymptotic Giant Branch (SAGB) phase. We present a set of constant rest-mass ultra-massive oxygen/neon (O/Ne) white dwarf cooling tracks with masses above $M > 1.29 M_{\odot}$ which fully take into account the effects of general relativity on the structural and evolutionary properties of the evolving white dwarfs. The sequences has been calculated with the La Plata stellar evolution code, `LPCODE`, which has been modified to fully include the effects of general relativity. For comparison purposes, the same sequences have been computed but for the Newtonian case. We find, as expected, that the importance of general relativistic effects increases as the stellar mass is increased. For the most massive white dwarfs, the resulting stellar radius is markedly smaller in the case where general relativity effects are taken into account. Also, the evolutionary properties of the most massive white dwarfs are strongly modified. In particular, the cooling time for our most massive white dwarf sequence results in about a factor of two smaller than in the Newtonian case at advanced stages of evolution. Finally, we find that chemical distribution due to phase separation on crystallization causes O/Ne white dwarfs with stellar masses larger than $1.36 M_{\odot}$ to become gravitationally unstable against general relativity effect, leading to a self-induced thermonuclear supernovae. We conclude that in the case of most massive white dwarfs, general relativity effects should be taken into account for an accurate assessment of the structural and evolutionary properties of these stars. These new models of ultra-massive white dwarfs constitute an improvement over those computed in the framework of the standard Newtonian theory of stellar interiors.