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A New C/O Plasma Melting Curve for White Dwarf Core Crystallization SIMON BLOUIN, JEROME DALIGAULT, DIDIER SAUMON, Los Alamos National Laboratory — White dwarfs are burned-out stars condemned to a slow cooling that extends over billions of years. Thanks to this simple evolution, it is relatively easy to measure their ages, making them useful cosmic clocks to study the history of our Galaxy. Eventually, the dense C/O plasma that makes up their cores becomes so correlated that it freezes. This process releases latent heat as well as gravitational energy due to the sedimentation of the O-enriched solid. This new energy source temporarily slows the cooling of the white dwarf and it is important to precisely model it if those stars are to be used for precision cosmochronology. Both the melting temperature and the importance of O sedimentation depend on the exact shape of the C/O phase diagram. We present a new C/O phase diagram obtained with the Gibbs-Duhem integration technique and semi-grand canonical Monte-Carlo simulations of the liquid and solid phases of the screened, partially relativistic, fully ionized mixture. This method—applied here for the first time to plasmas—allows us to obtain a definitive version of the classical C/O phase diagram, free of the limitations and approximations of previous calculations. Our results lead to an improved match between white dwarf evolution models and astronomical observations.

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