White Dwarf Donors in Ultracompact Binaries: The Stellar Structure of Finite Entropy Objects Christopher J. Deloye Department of Physics, Broida Hall, University of California, Santa Barbara, CA 93106 cjdeloye@physics.ucsb.edu Lars Bildsten Kavli Institute for Theoretical Physics and Department of Physics, Kohn Hall, University of California, Santa Barbara, CA 93106 bildsten@kitp.ucsb.edu

abstract We discuss the mass-radius ($M-R$) relations for low-mass ($M < 0.1$) white dwarfs (WDs) of arbitrary degeneracy and evolved (He, C, O) composition. We do so with both a simple analytical model and models calculated by integration of hydrostatic balance using a modern equation of state valid for fully ionized plasmas. The $M-R$ plane is divided into three regions where either Coulomb physics, degenerate electrons or a classical gas dominate the WD structure. For a given $M$ and central temperature, $T_c$, the $M-R$ relation has two branches differentiated by the model’s entropy content. We present the $M-R$ relations for a sequence of constant entropy WDs of arbitrary degeneracy parameterized by $M$ and $T_c$ for pure He, C, and O. We discuss the applications of these models to the recently discovered accreting millisecond pulsars. We show the relationship between the orbital inclination for these binaries and the donor’s composition and $T_c$. In particular we find from orbital inclination constraints that the probability XTE J1807-294 can accommodate a He donor is approximately 15% while for XTE J0929-304, it is approximately 35%. We argue that if the donors in ultracompact systems evolve adiabatically, there should be 60-160 more systems at orbital periods of 40 min than at orbital periods of 10 min, depending on the donor’s composition. Tracks of our mass-radius relations for He, C, and O objects are available through the electronic version of this paper.