The angular momentum of isolated white dwarfs

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It has been known for a long time that the superficial layers of white dwarf stars rotate relatively slowly, with periods (measured mostly through spectroscopy or polarimetry) ranging from a few hours to tens of years. However, one could never exclude the possibility that the internal regions, inaccessible to direct observations, could spin quite rapidly and, hence, "hide" a large fraction of the angular momentum.
Asteroseismological inferences about the rotation state of pulsating white dwarfs have also been made under the assumption of solid body rotation, but nothing could be said about the extent of the stellar zone actually probed by the observed pulsation modes. Using a novel method that we developed recently, we are now able to map the internal rotation profile of a pulsating white dwarf (see Charpinet, Fontaine, & Brassard 2009, Nature, 461, 501). For instance, we find that the ZZ Ceti star GD 165 rotates slowly (57.09 ± 0.57 h) *and* rigidly over the outer 20% of its radius. Unfortunately, from the point of view of the question of the total angular momentum of the star, this outer region contains only $\sim 1\%$ of the total mass, and we cannot say if the internal regions of GD 165 rotate rapidly or not.
The outlook for mapping the internal rotation profile brightens up considerably when investigating the properties of the GW Vir pulsators. Indeed, our method can be efficiently used in these stars to map essentially all of the total mass and, therefore, infer or constrain the total angular momentum. After having demonstrated that PG 1159−035 rotates slowly (33.67 ± 0.24 h) *and* rigidly over some 99% of its mass, we have extented our approach to three other GW Vir pulsators and obtained similar results. We estimate that the ratio of the global rotation energy to the thermal energy varies from 3.2×10^{-8} to 1.6×10^{-6} in these objects, which proves eloquently that rotation has no longer any significant role to play in the destiny of these stars. Since they are fully representative of the post-AGB evolutionary phases, these stars indicate that, quite generally, isolated stars have lost essentially all of their angular momentum at this stage of their evolution.