

EVIDENCE THAT ALL DQ STARS ARE BINARY / MERGER PRODUCTS

J. Farihi

Department of Physics and Astronomy, University College London, London, WC1E 6BT, UK

There are now several independent lines of evidence that all DQ white dwarfs are the products of binary evolution or analogous mergers. 1) Post-common envelope binaries with a white dwarf and a main-sequence star are common, and while helium-rich DB and DC stars exist within this population, not one in over 3000 systems hosts a DQ star. This implies that any companions to DQ progenitors either never encountered the RGB or AGB envelopes, or were devoured during these evolutionary phases. 2) The classical DQ stars appear to be somewhat less massive than their DA counterparts, with a handful of compelling low-mass examples; together with their thin helium envelopes, these facts suggest a moderate or strong binary influence during their evolution. 3) Although challenging to measure due to the lack of atomic lines, DQ stars may be magnetic more often than their non-DQ counterparts, with a few examples of rapid rotation. 4) The nearest and well-studied DQ white dwarf Procyon B is understood to be inconsistent with single star evolution. 5) Lastly, DQ stars cannot be descended from either DA or DB white dwarfs that exhibit well-documented evidence for planetary debris and pollution over a significant fraction of their cooling ages. In stark contrast, the DQ pollution frequency is distinctly stunted, they have never been observed to have an infrared excess, and when detected, their metal abundances are 1000 times smaller than other polluted white dwarfs with similar cooling ages. The actual evolutionary pathway to DQ stars will require further stellar and binary evolution modeling, and investigations should consider relatively mundane possibilities such as the cannibalization of giant planets or low-mass stellar companions.