CONSTRAINTS ON THE DARK MATTER

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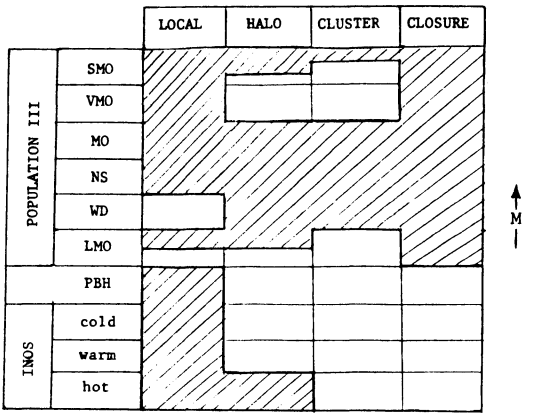
There is evidence for four types of dark matter: (1) the local d.m. in the galactic disc; (2) the d.m. associated with galactic halos; (3) the d.m. in clusters; and (4) a background closure density of d.m. required if the Universe undergoes an inflationary phase. There are three types of explanation: (1) remnants of a first generation of Population III stars, including black holes (SMOs, VMOs or MOs), neutron stars, white dwarfs, or LMOs (M-dwarfs and Jupiters); (2) elementary particle relicts of the Big Bang (inos), usefully classified - according to their mass - as hot, warm, or cold, since this determines the scale on which they can cluster; and (3) primordial black holes, formed from density perturbations or phase transitions in the early Universe. Various constraints on the d.m. candidates are indicated by the shaded regions in the Figure below. The conventional model of cosmological nucleosynthesis precludes Population III remnants providing the closure and perhaps cluster d.m., while stellar nucleosynthesis constraints preclude neutron stars from explaining anything and allow white dwarfs to provide only the local d.m. Source counts exclude M-dwarfs from providing the local or halo d.m., while gravitational lensing effects exclude SMOs larger than $10^8 M_\odot$ from explaining anything and LMOs or VMOs from having the closure density. Dynamical considerations imply $M<2M_\odot$ for the local d.m., $M<10^6 M_\odot$ for the halo d.m., and $M<10^9 M_\odot$ for the cluster d.m.; they also imply that the local d.m. cannot be inos and that the halo d.m. cannot be a hot ino. The table suggests the following conclusions: (1) no single candidate can explain all four d.m. problems; (2) the best candidate for the closure d.m. is an ino; (3) the best candidates for the local d.m. are white dwarfs or Jupiters; (4) the halo (and possibly cluster) d.m. could plausibly be black holes or Jupiters.



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