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Is Deuterium Cosmological?

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All the astronomical observations of deuterium are consistent with a cosmological origin of D. Deuterium has been extensively studied because it is not produced via stellar nucleosynthesis and is thought to be primarily produced via the big-bang so its abundance will only decrease with time unless there are additional sources of D. The D/H ratio is an important prediction of standard and non-homogeneous big-bang models because the abundance of D depends critically on the temperature and baryonic density during the epoch of nucleosynthesis (first 1000 seconds). In homogeneous inflationary or other flat models, the D/H ratio gives the amount of dark matter and an upper limit to the number of neutrino families. Any Galactic source of D would undermine its use to estimate the baryonic density of the universe and place constraints on big-bang nucleosynthesis models. D nucleosynthesis models have included supernovae, supernovae shock-waves, cosmic-ray spallation reactions, accretion disks around neutron stars or black holes, gamma-ray photospallation reactions, stellar flares, and a large proton flux during an early active phase of the Galaxy as possible sources for deuterium. If D is produced via any stellar or Galactic nucleosynthesis process, then its abundance would be a maximum value in the Galactic Center (which is the most active and heavily processed region of the Galaxy).

We review observations of deuterium in the Galaxy, external galaxies, active galaxies, and in quasar absorption systems, including our own observations. D has been detected in molecular clouds, diffuse clouds, HI regions, and HII region from observations of deuterated molecules, Lyman lines, Balmer lines, QSO absorption lines, and the DI 92-cm hyperfine-structure line. The Galactic D/H ratios range from 2 ppm in the Galactic Center to 23 ppm towards the anticenter (12 kpc from the GC). The QSO D/H ratios range from 20 – 30 ppm. Deuterium has not been detected in planetary nebulae, SNRs, or AGN. Because the D/H ratio is lowest value in the Galactic Center yet increases with distance from the Galactic Center, D is not produced via
stellar or galactic activity (massive stars and star formation, cosmic rays, or stellar flares). Thus the observed D is cosmological with the observed D abundances reduced by astration, infall, mixing, and depletion onto grains.

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