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Julius Edgar Lilienfeld Prize (2020): New Challenges in Cosmology, Galaxy Formation, and Planets

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The Hubble tension between early universe and local measurements of H0 can be resolved by a brief episode of dark energy contributing about 10Dark Energy scenario predicts earlier structure formation, e.g. 50more clusters than CDM at redshift z 1. Galaxies were long thought to start as disks, but HST images show that most galaxies instead start prolate (pickle shaped). Galaxy simulations can explain this as a consequence of the filamentary nature of the CDM dark matter distribution. But comparisons between simulations and observations using novel machine learning methods reveal other potential challenges. Earth may be a radioactively Goldilocks planet, with just the right amount of radiogenic heating by Th and U for plate tectonics and a magnetic field both of which may be necessary for the evolution of complex life. Production of these elements in rare neutron star mergers implies incomplete mixing. A factor of 2 increase would have stopped Earths magnetic dynamo for hundreds of millions of years and also caused widespread vulcanism. A factor of 2 decrease could have stopped plate tectonics