



X-RAY ASTRONOMY 2019

Current Challenges and New Frontiers in the Next Decade

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Probing cluster formation from cosmic noon to cosmic dawn

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The study of the formation of galaxy clusters is incomplete without connecting measurements of clusters at low redshifts to their progenitor structures in the early universe. New surveys are now finding significant numbers of these cluster progenitors at $z > 2$ with relative ease. While some of these are associated with powerful active galaxies (radio galaxies and quasars) that are good signposts for the progenitors of massive central cluster galaxies, the majority of structures being identified today are found based on large-scale overdensities of galaxies in deep, wide optical surveys, enhancements in the hydrogen optical depth as measured by tomographic studies of the intergalactic medium, and large spatial excesses of redshifted dust continuum emission from cluster-forming regions. These large structures of galaxies may furthermore have played an important role in the reionization of the universe, which can be tested by upcoming experiments. In this talk, I will review our current understanding of this rapidly growing field and the main challenges in the next decade.

Topic

The cosmic frontier: first black holes and proto-clusters

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