



**Chandra X-ray  
Observatory Center**

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**Abell 262, Abell 383, Abell 1413, and Abell 2390:** A sample of galaxy clusters used to study dark matter.

(Credit: X-ray: NASA/CXC/Cinestav/T.Bernal et al.; Optical: Adam Block/Mt. Lemmon SkyCenter/U. Arizona)

**Caption:** Astronomers used Chandra observations of 13 galaxy clusters to study the properties of dark matter. Specifically, researchers tested a model using a principle in quantum mechanics that each subatomic particle has a wave associated with it. To a distant observer at a great distance, the interaction of these waves with dark matter would make the particles appear fuzzy, if they could be directly observed. Although the simplest fuzzy dark matter model did not match the Chandra data, a version where the particles had different amounts of energy – the “excited states” – did give good agreement with the data, thus providing promise for theoreticians trying to better understand dark matter.

**Scale:** **Abell 262:** Image is 6.3 arcmin (about 440 million light years) across. **Abell 383:** Image is 2.0 arcmin (about 1.2 billion light years) across. **Abell 1413:** Image is 2.2 arcmin (about 1.1 billion light years) across. **Abell 2390:** Image is 4.2 arcmin (about 3.0 billion light years) across.

*Chandra X-ray Observatory ACIS Image*

*CXC operated for NASA by the Smithsonian Astrophysical Observatory*