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A Joint Chandra and XMM-Newton View of Abell 3158: Massive Off-Centre Cool Gas Clump As A Robust Diagnostic of Merger Stage

Yu Wang, Haiguang Xu, Liyi Gu, Junhua Gu, Zhenzhen Qin, Jingying Wang, Zhongli Zhang, Xiang-Ping Wu

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By analysing the Chandra and XMM-Newton archived data of the nearby galaxy cluster Abell 3158, which was reported to possess a relatively regular, relaxed morphology in the X-ray band in previous works, we identify a bow edge-shaped discontinuity in the X-ray surface brightness distribution at about $120h_{71}^{-1}$ kpc west of the X-ray peak. This feature is found to be associated with a massive, off-centre cool gas clump, and actually forms the west boundary of the cool clump. We find that the cool gas clump is moving at a subsonic velocity of ~ 700 km/s toward west on the sky plane. We exclude the possibility that this cool clump was formed by local inhomogeneous radiative cooling in the intra-cluster medium, due to the effectiveness of the thermal conduction on the time-scale of ~ 0.3 Gyr. Since no evidence for central AGN activity has been found in Abell 3158, and this cool clump bears many similarities to the off-centre cool gas clumps detected in other merging clusters in terms of their mass, size, location, and thermal properties (e.g. lower temperature and higher abundance as compared with the environment), we speculate that the cool clump in Abell 3158 was caused by a merger event, and is the remnant of the original central cool-core of the main cluster or the infalling sub-cluster. This idea is supported not only by the study of line-of-sight velocity distribution of the cluster member galaxies, but also by the study of gas entropy-temperature correlation. This example shows that the appearance of such massive, off-centre cool gas clumps can be used to diagnose the dynamical state of a cluster, especially when prominent shocks and cold fronts are absent.

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