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Connecting the metallicity dependence and redshift evolution of HMXBs

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In the local Universe, it is observed that the X-ray luminosity (L_X) of HMXB populations is correlated with the host galaxy's star formation rate (SFR). Recent X-ray studies of high-redshift galaxies find a positive evolution of this correlation with redshift. This trend is attributed to the formation of more luminous HMXBs in lower metallicity (Z) environments, as predicted by binary population synthesis models. While there is observational evidence that HMXB populations in nearby low-Z dwarf galaxies have enhanced L_X/SFR, the correlation between L_X, SFR, and Z is poorly constrained and, due to the difficulty of obtaining Z measurements at high redshift, it has not yet been proven that the redshift evolution of L_X/SFR is driven by the Z-dependence of HMXBs. Better understanding how HMXB L_X varies with Z and redshift will constrain: (1) whether HMXBs in low-Z environments can be progenitors of the heavy BH binaries discovered by gravitational wave observatories, (2) the contribution of HMXBs to the X-ray heating and reionization of gas in the early Universe, and (3) estimates of HMXB contamination to X-ray searches for low-luminosity AGN and intermediate mass black holes.
We present the results of an X-ray stacking study of star-forming galaxies at z~2, whose goal is to test the connection between the redshift evolution and Z-dependence of HMXBs. Our galaxy sample is selected from the MOSDEF survey, which obtained rest-frame optical spectra of ~1500 galaxies at z~2 in the CANDELS fields. Stacking Chandra data from these fields, we confirm that the L_X/SFR of galaxies at z~2 is enhanced relative to z=0. Splitting our sample into different Z bins, we find a statistically significant decrease of L_X/SFR with Z that is in good agreement with theoretical predictions and with the L_X-SFR-Z relation in the local Universe. Thus, this study provides the first direct evidence that the z-evolution of the HMXB L_X/SFR is indeed driven by metallicity. We also present preliminary results from X-ray stacking studies at lower redshifts, which will better constrain the L_X-SFR-Z relation, enabling more detailed comparisons with theoretical models.

Topic

Compact and diffuse sources in galaxies and in the Galactic Center

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