The Bright SHARC Survey: The Selection Function and its Impact on the Cluster X-ray Luminosity Function

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abstract

We present the results of a comprehensive set of simulations designed to quantify the selection function of the Bright SHARC survey (Romer et al. 2000a) for distant clusters. The statistical significance of the simulations relied on the creation of many thousands of artificial clusters with redshifts and luminosities in the range $0.25 < z < 0.95$ and $0.5 < L_X < 10 \times 10^{44}$ erg s$^{-1}$ (0.5–2.0 keV). We created 1 standard and 19 varied distribution functions, each of which assumed a different set of cluster, cosmological and operational parameters. The parameters we varied included the values of $\Omega_0$, $\Omega_\Lambda$, $\beta$, core radius ($r_c$) and ellipticity ($e$). We also investigated how non-standard surface brightness profiles (i.e. the Navarro, Frenk & White 1997, NFW, model); cooling flows; and the ROSAT pointing target, influence the selection function in the Bright SHARC survey. For our standard set we adopted the parameters used during the derivation of the Bright SHARC Cluster X-ray Luminosity Function (CXLF, Nichol et al. 1999, N99), i.e. $\Omega_0 = 1$, $\Omega_\Lambda = 0$ and an isothermal $\beta$ model with $\beta=0.67$, $r_c=250$ kpc and $e = 0.15$. We found that certain parameters have a dramatic effect on our ability to detect clusters, e.g. the presence of a NFW profile or a strong cooling flow profile, or the value of $r_c$ and $\beta$. Other parameters had very little effect, e.g. the type of ROSAT target and the cluster ellipticity. At distant redshift ($z > 0.8$), elliptical clusters are significantly easier to detect than spherical ones in the Bright SHARC survey. We show also that all the tested parameters have only a small influence on the computed luminosity of the clusters (recovered luminosity in the text) except the presence of a strong cooling flow. We conclude that the CXLF presented in N99 is robust (under the assumption of standard parameters), but stress the importance of cluster follow-up, by Chandra and XMM, in order to better constrain the morphology of the distant clusters found in the Bright SHARC and other surveys.