Response to the Document “Origin of the Extended EUV Emission from the Abell 2199 and Abell 1795 Clusters of Galaxies” by Lieu, Mittaz, Bonamente, Durret and Kaastra

S. Bowyer, T. Berghöfer, and E. Korpela

Lieu, Mittaz, Bonamente, Durret and Kaastra (hereafter, Lieu et al.) have provided a document which claims to rebut the finding by Bowyer, Berghöfer and Korpela (hereafter, BBK) presented at the Ringburg Workshop (April 1999) that excess EUV emission detected in some clusters of galaxies is in an artifact of the background subtraction employed.

We invite interested observers to carry out this analysis for themselves, but we realize this may take a substantial effort, and not everyone will have the necessary tools readily available. Hence we here provide some relevant information and discuss the points raised by Lieu et al.

The central point is that the EUVE Deep Survey Telescope response is not flat. This is not unique to EUVE. All space borne and ground based telescopes show this feature to some extent and data from these telescopes are routinely corrected with a vignetting function, or flat-fielding. In Fig. 1 below, we provide a sensitivity plot of the EUVE Deep Survey Telescope obtained by long observations of blank sky. Each contour is a 10% sensitivity level change. A detailed version of this response, useful for considering small-scale variations in the detector that might be thought of as variations in the detailed cluster emission, is available at [http://sag-www.ssl.berkeley.edu/~korpela/euve_cdf].

Given the obvious variation in sensitivity over the field of view of this telescope, we do not understand how anyone can claim that a flat background as employed by Lieu et al. is correct and appropriate for analyses of extended features.

Nonetheless, in their Figure 3, replicated below, Lieu et al. do claim that this background is flat. However, it is visually obvious that the data in this figure are not compatible with a flat background. A simple Chi-squared test is something anyone can easily do with the data in this figure; we find a reduced Chi-square of 1.7 for the best fit flat line, and a reduced Chi-square of 0.93 for the best fit sloped line. The decrease in the background with increasing radius seen in this figure is precisely the effect that we have brought to everyone’s attention.

In their Figure 3, Lieu et al. place their ”flat” background level at a rough average of their data points and claim this to be the average ”flat” value. In their analyses of cluster emission they place their background level near the lowest of their outlying data points. It is not surprising that by using this method of determining the background level they find
Lieu et al. make a number of other points which they claim buttress their view.

1. They state, "The CSE effect was confirmed by the LECS instrument aboard BeppoSax." The validity of this "confirmation" is not clear. The preliminary BeppoSax analysis now available uses theoretical functions for several of the key data reductions, rather than in-flight derived values. A more thorough analysis is currently underway (Kaastra, private communication).

2. "A multi-scale wavelet analysis of the EUVE/DS data of A 1795 shows clear signatures of cluster emission out to a radius of at least 8 arc minutes." We find that this "emission" is entirely a fine grained detector sensitivity effect. This can be verified by looking at the fine scale structure in the background sensitivity map provided at the above listed site. The "emission" appears to be different in different clusters because the observations were taken at different places on the detector and/or were taken with different thresholding and/or were taken at a combination of places on the detector. When the detector's small scale sensitivity is properly accounted for, this effect disappears.
3. Lieu et al. point out the additional background subtracted by us did not lead to the removal of CSE from the Virgo and Coma cluster data. They then state, "A natural puzzle is why these two clusters exhibit CSE..." It is indeed a puzzle why these two clusters exhibit CSE and others don't. The reason for this should be determined by future research. A clue may be provided by the fact that these two clusters exhibit substantial activity either in the form of merging or the presence of a high energy jet, while the other clusters are quiescent.

4. Lieu et al. state, "In fact, the rest (of the clusters) suffer from the opposite effect; they are strongly intrinsically absorbed." It is hard for us to understand why this is a problem. A similar effect has already been noted in X-ray observations of these clusters, and its underlying cause in terms of "cooling flow" gas was discussed in the presentation by Bowyer at the Ringburg Workshop.

5. The "Clincher test". We have difficulty in understanding all of the subtleties provided by Lieu et al. in this section, but their claim that the two raw data sets are essentially identical is correct. We stated this at the Workshop. Lieu et al. make a number of incorrect statements regarding the background levels observed. The particle background cannot be removed by pulse height thresholding as they claim, it can just be reduced. They make the statement that different observations can vary by a factor of two "mainly due to an increase in the photon background" and state that this is a crucial point. Unfortunately this is incorrect. The photon background is constant and the particle background is what changes in the EUVE Deep Survey Telescope as was pointed out in an extensive analysis by Lieu and co-workers. ("EUVE First Light Observations of the Diffuse Sky Background", Lieu, Bowyer, Lampton, Jelinsky, &
6. It is not true, as Lieu et al. claim, that ”within the context of the BBK scenario, the photon background must assume two templates, suitably correlated with each other as to produce the same absolute brightness profile.” The template is the same; it is shown in Figure 1. The only difference required is a normalization factor to account for the different (flat) particle background levels at the time of each observation.

7. The differences in the two data sets shown Figure 6 of Lieu et al. is simply explained. These observations were taken at different locations on the detector (as Lieu et al. state). The vignetting is different at each of these locations as can be seen in Figure 1, and hence the profiles will be different.

8. In ”Another Cosmic Conspiracy”, Lieu et al. state ”one will be forced to conclude that such a profile must apply to every cluster observed by EUV, i.e., all clusters must appear in the EUV like A 2199.” We disagree with this statement on several grounds. First, if the data were taken at different places on the detector, a cursory examination of Fig. 1 shows that the sensitivity deviations will be different and the cluster will look different. Second, there is EUV emission from the low energy continuation of the X-ray gas in clusters. Since the X-ray gas distribution is different in different clusters, the related EUV emission will be different in different clusters.

9. Lieu et al. incorrectly state that we find no emission in A2199 at radii larger than five arcminutes. Our analysis shows that the emission in A2199 extends to at least 9 arcminutes, but is entirely accounted for by the EUV tail of the X-ray emitting gas.

We challenge Lieu et al. to do the following: At each individual position where an observation of a cluster is made, derive an azimuthally averaged radial profile. Derive an azimuthally averaged radial profile of the background taken at this same location. Subtract from each a particle background as determined by count rates in highly vignetted regions near the edge of the filter. Fit the background profile at large radii to the source observations at large radii, and plot them on the same graph. Then share the results with all of us.