Documentation for Surface Brightness Calculations

Contents

1 Introduction

X-ray astronomy is known for a phenomenon aptly-monikered *photon-starvation*; this is amplified in certain cases when we are looking back at incredibly distant objects. Photon-starvation poses as serious issue when astronomers wish to determine whether or not a galactic cluster is a Cool-Core Cluster or not. With a strong signal-to-noise, one can "simply" use Weighted Voronoi Tesselations to construct an appropriate bin-map and then use **XSPEC** to develop a temperature map of the region. Unfortunately, for cases in which there is a dissapointingly low signal-to-noise, astronomers must resort to other measures: enter Surface Brightness Concentration Value (SBCV). Using this tool, we can comfortably determine whether or not an object is a CCC even with exceptionally low signal-to-noise. I will not delve into the details regarding the virtues of the SBCV but rather encourage any interested party to read the following papers: [1] [2] [3]. However, it is necessary to define this parameter:

$$SBCV = \frac{F(R < 40kpc)}{F(R < 400kpc)} \tag{1}$$

where F is the X-ray Flux and R represents the radius of the annulus.

According to [3], we are interested in the following regimes:

$$\begin{cases} \texttt{Non Cool Core} & SBCV < 0.075 \\ \texttt{Moderate Cool Core} & 0.075 < SBCV < 0.155 \\ \texttt{Strong Cool Core} & SBCV > 0.155 \end{cases}$$

2 Algorithm

The algorithm itself is not particularly complicated, but there are several crucial steps which makes it worth detailing.

Data: Reprocessed Fits File
Result: Surface Brightness Concentration Value with Bounds
Step 1: Use Astomety tool (*ASCalc.py*) – located in the *Astrometry* directory – to calculate the angular seperation for 40kpc and 400 kpc;
Step 2: Use this value (in arcseconds) in *ds9* to generate *.reg* files for 40/400kpc;
Step 3: Run *Precursor.py* – located in the *GeneralUse* directory – to generate *.arf* files for 40/400kpc;
Step 4: Calculate Monochromatic Energy AND Surface Brightness Coefficients using *SurfBright.py* which is located in the *SurfaceBrightness* directory;
Step 5: Calculate SBCV and bounds using *CSB.py* which is located in the *SurfaceBrightness* directory;

Algorithm 1: Surface Brightness Concentration Value

References

[1] J S Santos, P Tozzi, and P Rosati. The evolution of cool-core clusters. (2005):1–14, 2018.

[2] Joana S Santos, Piero Rosati, Paolo Tozzi, B Hans, Stefano Ettori, and Andrea Bignamini. Searching for Cool Core Clusters at High redshift. (cc):1–14, 2018.

[3] D R Semler, R Suhada, K A Aird, M L N Ashby, M Bautz, M Bayliss, G Bazin, S Bocquet, B A Benson, L E Bleem, M Brodwin, J E Carlstrom, C L Chang, H M Cho, A Clocchiatti, T M Crawford, A T Crites, T De Haan, S Desai, M A Dobbs, J P Dudley, R J Foley, E M George, M D Gladders, A H Gonzalez, N W Halverson, N L Harrington, F W High, G P Holder, W L Holzapfel, S Hoover, J D Hrubes, C Jones, M Joy, R Keisler, L Knox, A T Lee, E M Leitch, J Liu, M Lueker, A Mantz, D P Marrone, M Mcdonald, J J Mcmahon, J Mehl, S S Meyer, L Mocanu, J J Mohr, T E Montroy, S S Murray, T Natoli, S Padin, T Plagge, C Pryke, C L Reichardt, A Rest, J Ruel, J E Ruhl, B R Saliwanchik, A Saro, J T Sayre, K K Schaffer, L Shaw, E Shirokoff, J Song, H G Spieler, B Stalder, Z Staniszewski, A A Stark, K Story, C W Stubbs, A Van Engelen, K Vanderlinde, J D Vieira, A Vikhlinin, R Williamson, O Zahn, and A Zenteno. High-redshift cool-core galaxy clusters detected via the sunyaev–zel'dovich effect in the south pole telescope survey 1. 2012.