Measuring distances of galaxies emitting in X-rays

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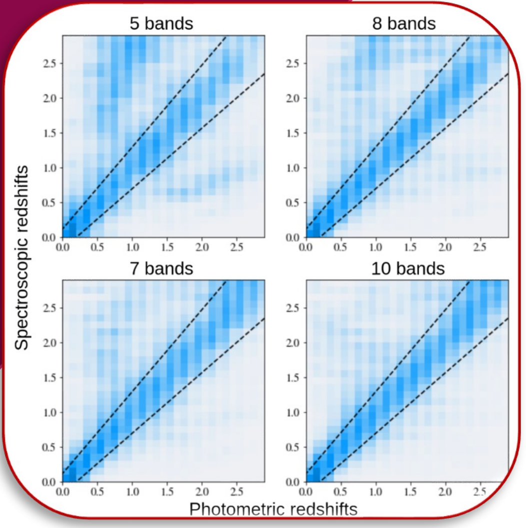
XMM2ATHENA

One of the first questions that comes to our minds when we look at the night sky is "how far the stars are from us". This question is very important for astronomers and over the years we discovered many different methods to measure distances for stars and even for very distant galaxies. But why are distances important? Without knowing the distances to different celestial objects it is impossible to compare their "intrinsic" properties. For example, the Sun is the brightest star that we can observe, but this is just because it is very close to us. Once we took distances into account, we found out that there are much more luminous stars in our Galaxy.

In XMM2Athena we want to measure the distances of X-ray emitting objects that are detected by the XMM-*Newton* observatory. Most of these objects are active galaxies very far from us, at what we call "cosmological" distances. This means that they are receding from our galaxy at very high velocities, as a consequence of the expansion of the Universe. And thanks to this, we can estimate its distance by measuring a simple observational property: the redshift. The light emitted by distant galaxies moving away from us shifts towards lower frequencies, towards the red part of the electromagnetic spectrum.

The most direct way of knowing the redshift of a galaxy is by measuring its spectrum (spectroscopic redshifts). This is very time consuming and it is not feasible when you want redshifts for hundreds of thousands of sources, as in the case of XMM2Athena. However, we have available a different method for measuring redshifts, called photometric redshifts. This is based on the fact that the different colors we observe in a galaxy depend on its distance. This technique is less accurate than spectroscopic redshift, but it gives good results.

We calculate photometric redshifts using Machine Learning methods. We use a small sample of X-ray sources with known spectroscopic redshifts to train an Artificial Intelligence so it can assign redshifts for X-ray sources based on their observed colors. In the figure we show the results of this method, comparing our values for the photometric redshifts with known spectroscopic redshifts. The dark areas are the regions where most of our measurements are concentrated. If these regions lie within the dashed lines, then for most sources the photometric redshifts are calculated correctly. When including more colors (bands) in our calculations, the results get better.



This figure compares the estimated photometric values we obtained using our Machine Learning method with the corresponding spectroscopic redshifts. The darker regions in each panel show the areas where most of the sources are concentrated. The dashed lines in the central part show the region where spectroscopic and photometric redshifts are in good agreement. Each panel shows the results of our estimations when using a different amount of photometric bands (how many photometric points we introduce in our algorithm).

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