



Contribution ID: 70

Type: Poster

Galaxy cluster detection on SDSS images using deep machine learning

Galaxy clusters are a powerful probe of cosmological models. Next generation large-scale optical and infrared surveys will reach unprecedented depths over large areas and require highly complete and pure cluster catalogs, with a well defined selection function. We have developed a new cluster detection algorithm YOLO-CL, which is a modified version of the state-of-the-art object detection deep convolutional network YOLO, optimized for the detection of galaxy clusters (Grishin, Mei, Ilic 2023). We trained YOLO-CL on color images of the redMaPPer cluster detections in the SDSS. We find that YOLO-CL detects 95–98% of the redMaPPer clusters, with a purity of 95–98% calculated by applying the network to SDSS blank fields. When compared to the MCXC2021 X-ray catalog in the SDSS footprint, YOLO-CL is more complete than redMaPPer, which means that the neural network improved the cluster detection efficiency of its training sample: it detects 98% of clusters with mean X-ray surface brightness of $20 \times 10^{-15} \text{ erg/s/cm}^2/\text{arcmin}^2$ while redMaPPer is 98% complete above $55 \times 10^{-15} \text{ erg/s/cm}^2/\text{arcmin}^2$. The YOLO-CL selection function is approximately constant with redshift, with respect to the MCXC2021 cluster mean X-ray surface brightness. YOLO-CL shows high performance when compared to traditional detection algorithms applied to SDSS. Deep learning networks benefit from a strong advantage over traditional galaxy cluster detection techniques because they do not need galaxy photometric and photometric redshift catalogs. This eliminates systematic uncertainties that can be introduced during source detection, and photometry and photometric redshift measurements. Our results show that YOLO-CL is an efficient alternative to traditional cluster detection methods. In general, this work shows that it is worth exploring the performance of deep convolutional networks for future cosmological cluster surveys, such as the Rubin/LSST, Euclid or the Roman Space Telescope surveys.

Primary authors: GRISHIN, Kirill (Astroparticule et Cosmologie (APC)); Prof. MEI, Simona (AstroParticule et Cosmologie (APC)); Mr ILIC, Stephane (IJCLab, Université Paris-Saclay)

Presenter: GRISHIN, Kirill (Astroparticule et Cosmologie (APC))

Session Classification: Posters

Track Classification: Paris