Publications of the Korean Astronomical Society
27: 151 ∼ 152, 2012 September

ISSN 1225-1534 (Print)
http://dx.doi.org/10.5303/PKAS.2012.27.4.151

A MULTICOLOR STAR-GALAXY SEPARATION FROM THE NIR AND MIR AKARI DATA

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(Received June 29, 2012; Accepted August 01, 2012)

ABSTRACT

We present the method of star/galaxy separation based on the support vector machines (SVM) in the data from the AKARI North Ecliptic Pole (NEP) Deep survey collected through nine AKARI / IRC bands from 2 to 24 μm, with a classification accuracy of 93 %.

Key words: surveys; infrared: galaxies; dust, extinction; galaxies: fundamental parameters; infrared: stars

1. INTRODUCTION

AKARI satellite, in addition to the All Sky Survey, carried out the observations of the NEP Deep field, which covers an area of 0.6 sq. deg (see Takagi et al., 2012). The data were obtained by the Infra-red Camera (IRC) through nine near- and mid-infrared (NIR and MIR) filters, and reached the limiting magnitudes of 26.86 [mag] in NIR-bands.

AKARI data have to be categorized based on the photometric data because detailed spectroscopic follow-up observations are expensive and much more time consuming. The methods designed up to now (i.e. color-color diagrams: Pollo et al., 2010) cannot be applied directly to NEP data, since they concern different wavebands and shallower catalogs.

In general, classification methods are based on a pattern recognition within the data sets. For every object we have a vector describing its characteristic features. We can use a mapping function, called a classifier, to transfer feature vectors into discriminant ones, which contain likelihoods of the given object to belong to one of the considered classes. In this work we use the Supporting Vector Machine (SVM) classifiers (Vapnik, 1995) based on kernel functions, which are used to map input vectors non-linearly into a high dimensional parameter space and construct an optimal separating hyperplane. With AKARI IRC flux measurements we build a 6D parameter space by using color indexes. We create two training samples containing stars and galaxies chosen by their stellarity parameter (sgc) value measured in NIR to train SVM and obtain its classifier.

2. STAR-GALAXY SEPARATION

After training the algorithms to get the most optimal results we obtained the total classification accuracy of 93%, with specific accuracies of 98% for selecting stars and 90% for selecting galaxies. To test the reliability of our classification we project the constructed 6D multicolor space into a standard 2-color space and confront it with the fact that stars radiate strongly in narrow passbands of short wavelengths, while galaxies, due to the variety of components comprising the spectra and their distance to the observer will possess much redder colors with a larger color discrepancy (see Fig. 1).

As a confirmation of the accuracy of the presented method we created the Euclidean normalized number counts, where we compare stellar counts with Faint Source Model (Arendt et al., 1998; hereafter FSM), to assess the reliability of our results with the theoretical predictions. The raw counts show high consistency

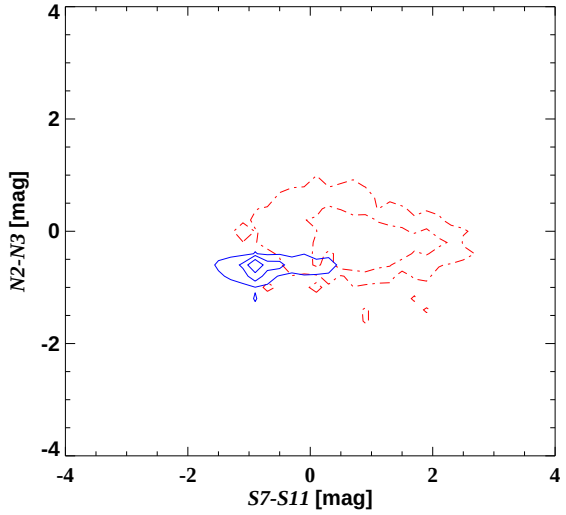

Fig. 1. Projection of the SVM classification from multicolor space onto $N2-N3$, $S7-S11$ parameter space. Solid contours represent the occupancy zone for stars, dashed contours for galaxies.

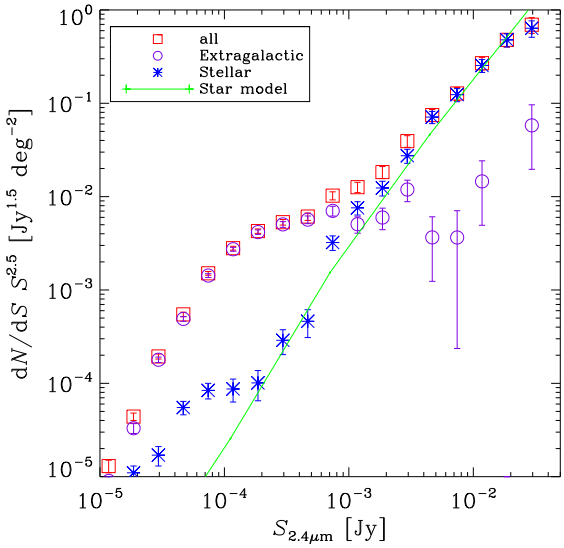

Fig. 2. Euclidean normalized number counts for the considered classes of objects in the sample for $N2$ band. Error bars represent Poisson uncertainty in logarithmic units.

with the FSM (see Fig. 2), which proves that stars indeed dominate at the bright end of the counts. The stellar counts precisely follow the theoretical predictions, and the extragalactic counts display distinctive features: a bump in counts is visible at $S_\nu \sim 3$ mJy together with an upturn at the brightest end. At $S_\nu \sim 1$ mJy the counts slightly increase, signaling positive source evolution. To **summarize**, we developed a method for distinguishing objects of different natures in the deep infrared surveys carried out without any previous target object selection, based on the photometric measurements alone (Solarz et al., 2012). We have used all color information simultaneously to create a very efficient classifier based on SVM method that reached high accuracies in selecting both stars and galaxies, which we have confirmed by comparing the source counts with theoretical predictions.

ACKNOWLEDGEMENTS

This work is based on observations with AKARI, a JAXA project with the participation of ESA. AP has been supported by the research grant of the Polish National Science Centre N N203 51 29 38. This research was partially supported by the project POLISH-SWISS ASTRO PROJECT co-financed by a grant from Switzerland through the Swiss Contribution to the enlarged European Union. TTT has been supported by the Grant-in- Aid for the Scientific Research Fund (20740105, 23340046, and 24111707) and for the Global COE Program Request for Fundamental Principles in the Universe: from Particles to the Solar System and the Cosmos commissioned by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan.

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