GLADE and its astrophysical applications

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Outline

Motivation

Main motivation: to support target selections and host galaxy identifications in GW-triggered EM follow-up observations. Most important parameters are B mag, z and possibly IR magnitudes (they correlate with the stellar mass of the galaxy; see [1]).

Catalog used in the initial detector era: GWGC [2]

- Contains 53,255 galaxies
- Complete out to 40 Mpc

Higher completeness (even out to $\sim$ 300 Mpc) is needed in the advanced detector era. [3]

[1] Wen, X-Q., Wu, H., Zhu, Y.-N. et al., 2013, MNRAS, doi:10.1093/mnras/stt939

[2] White, D. J., Daw, E. J. & Dhillon, V. S., 2011, Class. Quantum Grav., 28 085016

[3] Evans, P. A, Osborne, J. P., Kennea, J. A. et al., 2015, astro-ph/1506.01624

Catalogs used

2MASS XSC [1]

- 1,646,844 galaxies
- contains no distances or B-band magnitudes

2MPZ (value added, 2MASS + WISE + SuperCOSMOS) [2]

- 928,353 galaxies
- photometric redshift and B-band magnitude for every galaxy

HyperLEDA [3]

- 836,388 galaxies
- we improved the galaxy-quasar separation and left out quasars

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[1] http://www.ipac.caltech.edu/2mass/

[2] Bilicki, M., Jarrett, T. H., Peacock, J. A. et al., 2014, ApJS, 210 16 pp.

[3] http://leda.univ-lyon1.fr/

Filling in missing data

2MASS galaxies do not have B mag and $z \rightarrow$ 2MPZ

We have a non-LIGO member machine learning-expert in our group (R. S. de Souza).

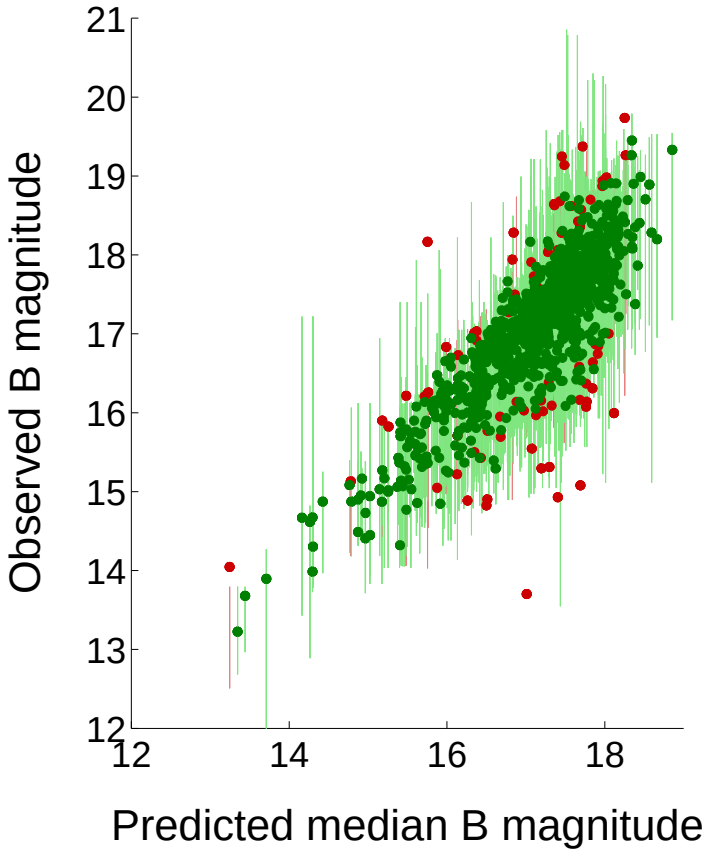
Random forest algorithm: a robust methodology, requires little fine tuning. [1]

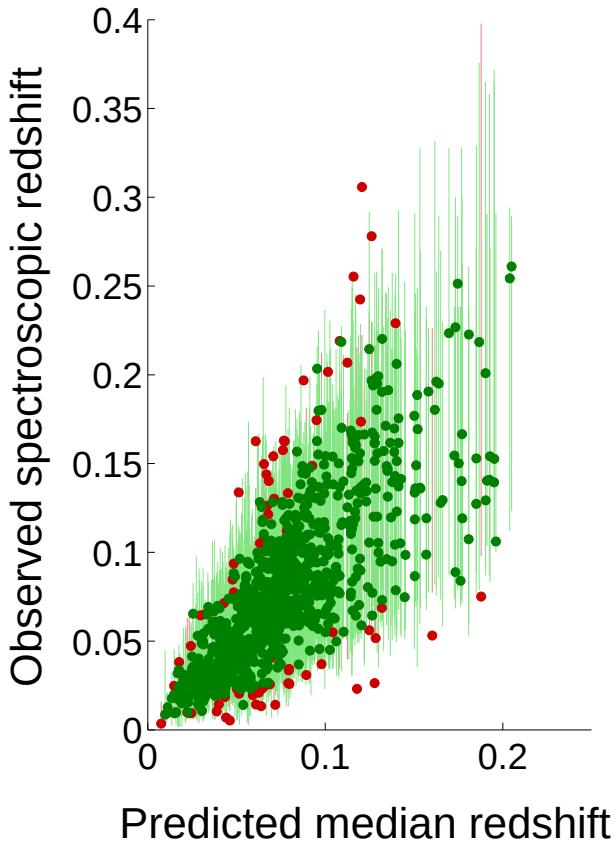
Teaching sample: 10,000 2MPZ galaxies, learning based on J, H, K magnitudes

Associated parameters to $\sim$ 550,000 galaxies

[1] Meinshausen, N., 2006, Journal of Machine Learning Research, 7 983

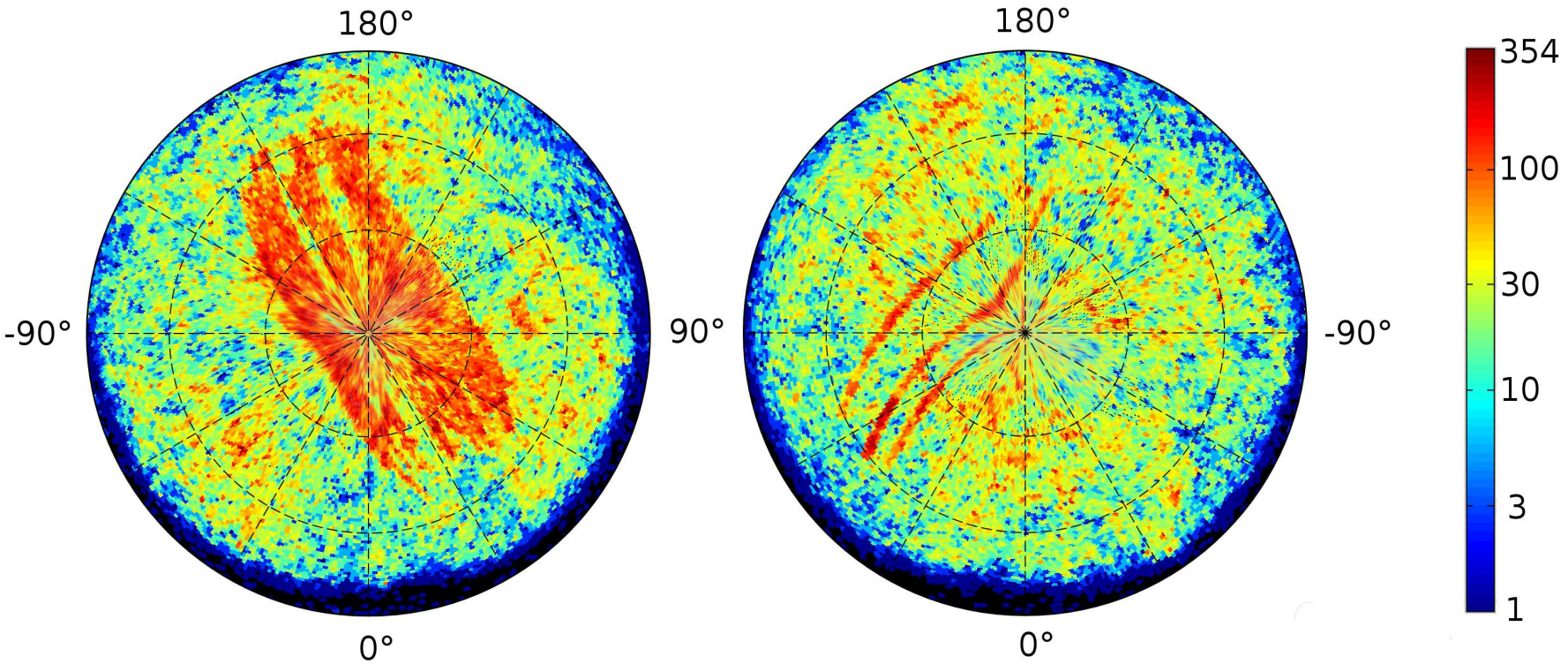
Filling in missing data





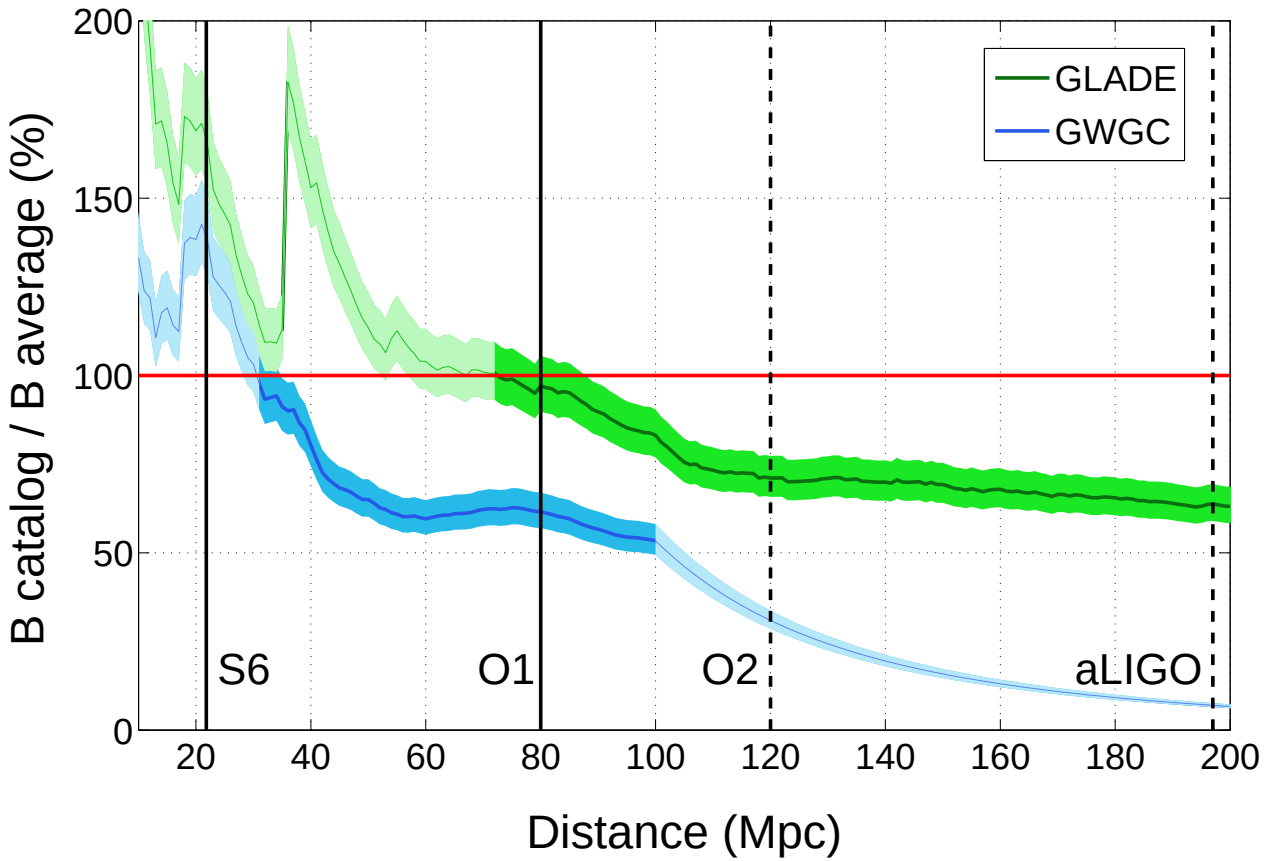
Density of galaxies

A total of 1,918,147 galaxies



Completeness

Using the same method as in the GWGC paper. [1]
Expected blue luminosity density: $(1.98 \pm 0.16) \cdot 10^{-2}$ L_{10} Mpc^{-3} . [2]



100% out to 73 Mpc

At O2 BNS: 71%

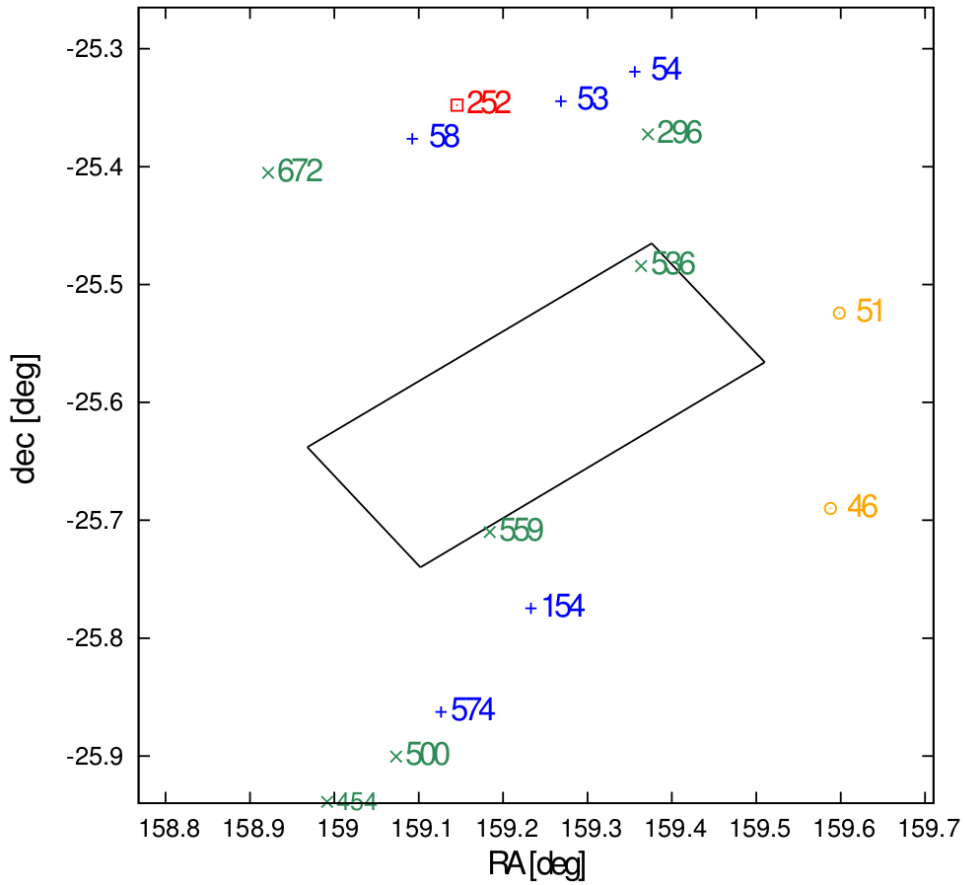
[1] White, D. J., Daw, E. J. & Dhillon, V. S., 2011, Class. Quantum Grav., 28 085016

[2] Kopparapu, R. K., Hanna, C., Kalogera, V. et al., 2008, ApJ, 675, 1495

GRB host identification

GLADE is already in use in an automatized host galaxy identification for gamma-ray bursts observed by the InterPlanetary Network.

`aquarius.elte.hu/glade/GRB.html`



Skymap enhancement

Current skymap creation: Bayesian framework, uniform prior, posterior probability distribution

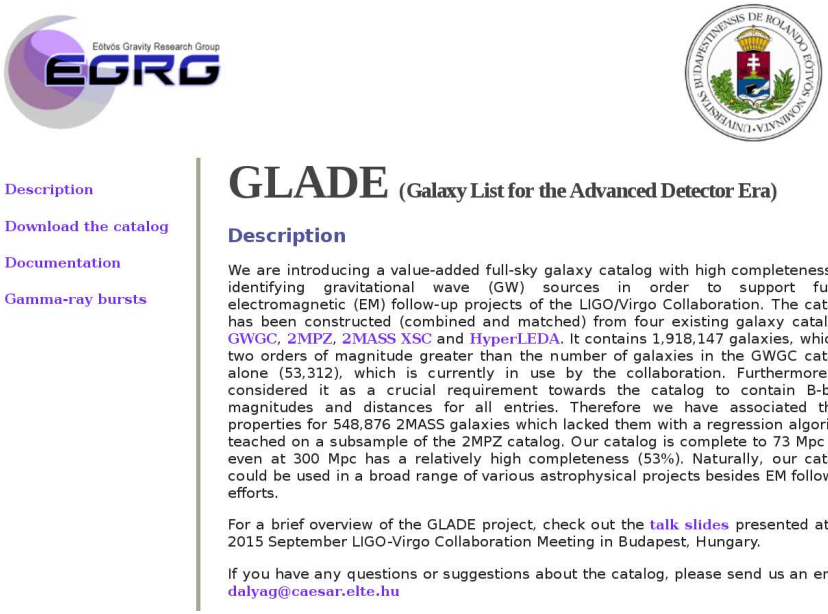
The distribution of galaxies on the sky could be taken as a prior for creating skymaps → guide EM follow-up observations to focus on the particular galaxies with high posterior probability [1]

[1] Fan, X., Messenger, C., & Heng, I. S. 2014, ApJ, 795, 43

Website

You can download the catalog and read its documentation using the website:

`aquarius.elte.hu/glade/`



Eötvös Gravity Research Group

EGRG

- Description
- Download the catalog
- Documentation
- Gamma-ray bursts

GLADE (Galaxy List for the Advanced Detector Era)

Description

We are introducing a value-added full-sky galaxy catalog with high completeness for identifying gravitational wave (GW) sources in order to support future electromagnetic (EM) follow-up projects of the LIGO/Virgo Collaboration. The catalog has been constructed (combined and matched) from four existing galaxy catalogs: GWGC, 2MPZ, 2MASS XSC and HyperLEDA. It contains 1,918,147 galaxies, which is two orders of magnitude greater than the number of galaxies in the GWGC catalog alone (53,312), which is currently in use by the collaboration. Furthermore we considered it as a crucial requirement towards the catalog to contain B-band magnitudes and distances for all entries. Therefore we have associated these properties for 548,876 2MASS galaxies which lacked them with a regression algorithm teached on a subsample of the 2MPZ catalog. Our catalog is complete to 73 Mpc and even at 300 Mpc has a relatively high completeness (53%). Naturally, our catalog could be used in a broad range of various astrophysical projects besides EM follow-up efforts.

For a brief overview of the GLADE project, check out the talk slides presented at the 2015 September LIGO-Virgo Collaboration Meeting in Budapest, Hungary.

If you have any questions or suggestions about the catalog, please send us an email: dalyag@caesar.elte.hu

GLADE: An Extended List of Galaxies for Gravitational-Wave Searches in the Advanced Detector Era

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ABSTRACT
We are introducing GLADE (Galaxy List for the Advanced Detector Era), a value-added full-sky galaxy catalog with high completeness to support future EM follow-up observations of the LIGO–Virgo Collaboration. The catalogue has been constructed (combined and matched) from four existing galaxy catalogs: GWGC, 2MPZ, 2MASS XSC and HyperLEDA. It contains 1,918,147 galaxies, which is two orders of magnitude greater than the number of galaxies in the GWGC catalog, the catalogue currently used by the Collaboration comprising only 53,312 galaxies. Furthermore, we have associated B-band magnitudes and photometric redshifts to 548,876 2MASS galaxies which lacked these properties by applying a computational learning regression algorithm taught on a sub-sample of the 2MPZ catalogue. B magnitude was chosen as a measure of brightness because it is thought to be corralated with the binary neutron star forming rate, furthermore, it is needed for determining the completeness. Our catalogue is complete to 73 Mpc and even at 300 Mpc has a relatively high completeness (53%). Naturally, our catalogue could be used in a broad range of various astrophysical projects besides EM follow-up efforts.

The catalog can be freely downloaded from its website: http://aquarius.elte.hu/glade