Deccan Eductaion Society's
Fergusson College (Autonomous), Pune
Department of Physics

A Project Report on

Identifying lensed supernovae Ia from multi-band imaging data

As a part of BSc. (Physics) degree of Savitribai Phule Pune University

Submitted by
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CERTIFICATE

This is to certify that, Ms. Anushka Madhusudan Menon, Roll. no. 4315 of T.Y.B.Sc. Physics class of this department has satisfactorily completed the project entitled:
'Identifying lensed supernovae Ia from multi-band imaging data'
as part of completion of BSc. (Physics) degree of Savitribai Phule Pune University during the year 2019-2020.

Project Guide
(Internal)

Project Guide
(External)

Head, Department of Physics
Examiner Signature:

External Examiner

Internal Examiner

Date: 11th March, 2020

Acknowledgement

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Anushka M. Menon

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1 Introduction

As my interests lie particularly in Astronomy and Astrophysics, I had decided to pursue my bachelor research project in the same field. During a poster presentation, I came across a poster on lensing and further, on reading research papers and scientific articles on Gravitational Lensing, I found my interest inclined with the field. One of the papers I had read was: Detection of gravitational lensing magnifying a type Ia supernova by Robert Quimby et. al. Dr. Anupreeta More at IUCAA is one of the co-authors of the paper who specializes in the field of gravitational lensing. Thereafter, I approached Dr. Anupreeta More for an oppurtunity to do a research project on lensing under her guidance.

One of the consequence of Einsteins General Theory of Relativity is that light rays are deflected by gravity. The phenomena resulting from deflection of light in strong gravitational field is referred as Gravitational Lensing. Although lensing was predicted by Einstein in 1936, the first lensing caused by Quasars was observed in 1979. Lensing is a rare phenomena and it is difficult to differentiate lensed images from unlensed images. This formed the motivation for our project.

I started the project by understanding the theory behind lensing, on how lensing came to be predicted and later discovered, the types of lensing, the factors on which lensing depends and the research in the field. This was followed by getting well acquainted with python, analyzing software-glafic and various linux commands. As glafic is used extensively throughout our project, the manual of glafic had to be well-known so as to find and enter accurate parameters accordingly. We first fixed the type of galaxies causing the lensing and acting as host to the source and then assumed mass and light profiles for them respectively. We simulated the lensed images of supernova type Ia after studying the light curve, Philips relation, spectral energy distribution of the supernova type Ia. We did this task using a analyzing software glafic and with the help of programming using Python.

Through the course of the project report, we give an overview of the theory on lensing and various factors it depends on. It also highlights on the programming used and generated for obtaining the images and the insights acquired by studying these images. We conclude the report by discussing the results obtained and the future scope in the field of lensing.

2 Theoretical Background