A PCA-BASED STRONG GRAVITATIONAL LENS FINDER

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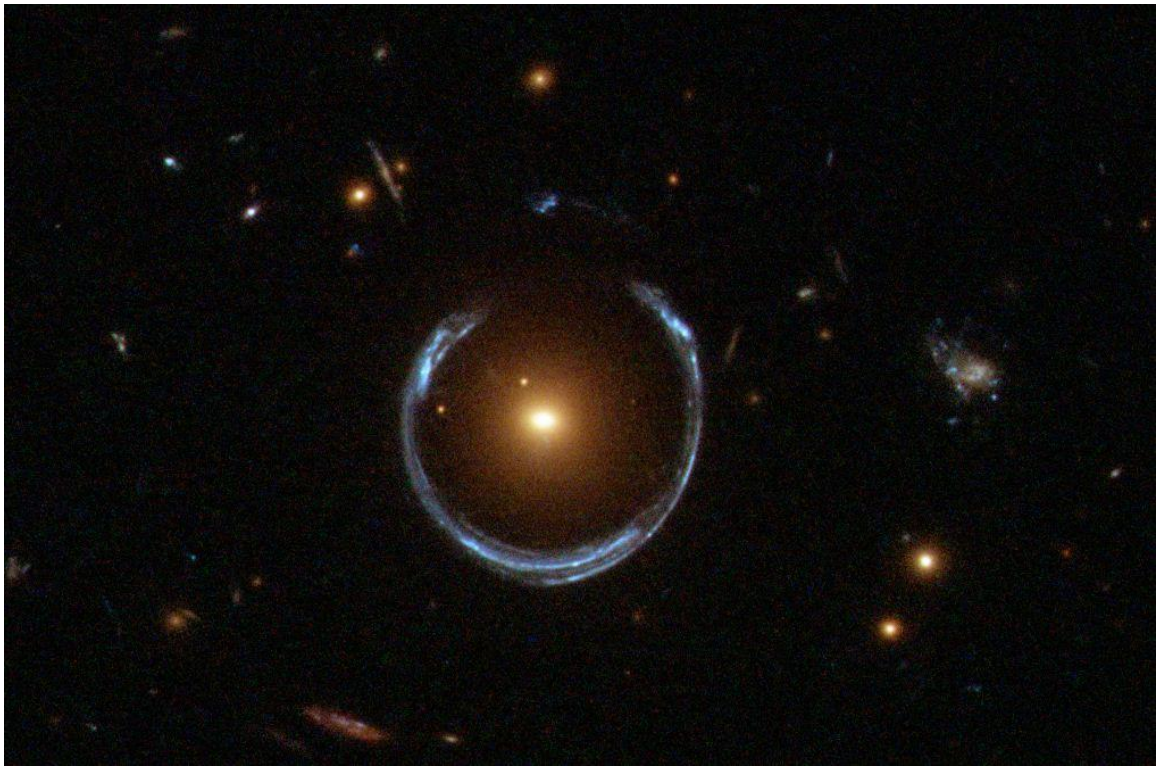
INTRODUCTION

Gravitational lensing is one of the most visible implications of Einstein's General Theory of Relativity. This effect predicts that light is bent by gravitational fields. In particular, if we have a heavy galaxy in directly front of a source of light in our line of sight, this effect causes ring- and arc-like features like those shown in the cover photo and in the picture below:



Identifying these features in petascale astronomical databases implies we need automated methods. The traditional method has been subtracting a galaxy fit source using a software like GALFIT and examining the residuals. Here we explore an alternative PCA-based approach to the same problem and try to find out if PCA works well in this scenario.

METHOD ADAPTED

We plan to implement the method in the paper Joseph, R., Courbin F. et al. 2014, *A PCA-based Automated Finder for Galaxy-Scale Strong Lenses*. The link to the paper is *http://arxiv.org/pdf/1403.1063v1.pdf*.

The method adapted here is slightly different as compared to the standard pattern recognition / machine learning model. Here the fact that the lensing patterns are rare among galaxies in general is used. We construct a PCA basis for aligned galaxy images using the train dataset. In this basis, the galaxies in the frame are represented adequately, and the lensing features, being rare, are under-represented. As a consequence, reconstructing the galaxy image from this basis yields mostly only the bright central core of the object. Subtracting the reconstructed image from the original image is therefore expected to yield the (non-reconstructed) lensing features. Denoising, thresholding and segmentation of the subtracted image can give an image (and hopefully measurements) of the features that further help in lens mass estimation.

CODE DETAILS

We will be coding in MATLAB and occasionally SQL to query astronomical databases for images. All code will be pushed to *https://www.github.com/AlankarKotwal/pca-lens-finder*.

DATASETS AND VALIDATION STRATEGY

Initial training and testing data will come from the simulated KiDS database, hosted at *http://bolognalensfactory.wordpress.com/home-2/blfkids-lens-finding-challenge/*. This database will be divided into two sets: One on which the train-test procedure will be applied and one which will be used for testing only. If time permits, we plan to use *CHFTLenS* data for more testing.