

# Siemens Competition

## Math : Science : Technology

### Regional Finalist

**Names:** Pranav Sivakumar and Janani Sivakumar

**High School:** Illinois Mathematics and Science Academy

**Mentor:** Sivakumar Muthuswamy

**Project Title:** *A Hybrid Photometric and Spectral Algorithm for Efficient Detection of Gravitationally Lensed Quasars (Astrophysics)*

A novel method was developed to identify gravitationally lensed quasars from the Sloan Digital Sky Survey (SDSS). The method consisted of two algorithms: a morphological algorithm directed at finding wide-separation lens candidates and a PSF-difference-based algorithm aimed at identifying close-separation lens candidates. Understanding gravitational lensing can help decipher the properties of dark matter and dark energy. It is hypothesized that if multiple objects in an SDSS image meet both spectral and photometric criteria, then these objects are possible images of a gravitationally lensed quasar. This project compiled data from over 300,000 quasars in the SDSS Data Release 10 and 592,313 neighbors within 16 arcseconds of each quasar. The data was retrieved and processed using Structured Query Language (SQL) queries. Using the data, the algorithms compared the quasars to their neighbors to determine if the neighbors were images of the same quasar. The results were validated against a control group of lensed quasars reported in the literature. Statistical analyses were also performed to ensure that the threshold criteria were consistent across the data set. A comparison of the project's results with established data sets of lensed quasars led to the conclusion that the hypothesis was well supported. In addition to identifying a majority of the quasars in the control group, the algorithms also identified additional high-probability lens candidates not reported in the literature.