Abstract

We propose to involve undergraduate physics majors in research by undertaking a new investigation of detecting and characterizing transits of exoplanets in solar-type stars in open clusters using a wide angle astrograph. Specifically we plan to use a f/1.5 152 mm apochromatic lens to observe open clusters and to perform ensemble photometry to identify periodic variable stars and previously unknown transit candidates.

Introduction

In 1999 the first successful observation of a transit of an extrasolar planet, HD 209458b, was made (Charbonneau 2000). The method soon became popular for two reasons: (1) the detection of a planetary transit around a bright star could be observed by telescopes as small as 20 cm in diameter; (2) observations studies of a planetary system seen edge-on provide data for directly measuring the radius and the mass. Ground-based transit searches like OGLE, and, more recently the space-based projects CoRoT and Kepler have expanded the number of planets observed by the transit method and major transit discoveries are expected. Transits provide information on the structure of planets, composition of atmospheres, and the presence of discs or rings (Charbonneau et al. 2007). To date hundreds of transits have been discovered and numerous ones by small telescopes with wide fields of view (O'Donovan et al. 2006, 2007)

The transit method consists in detecting the shallow dip in a stellar light curve—typically on the order of 0.01 magnitudes or 10 millimag, when a planet crosses the line of sight towards its host star during its revolution. For transits to be observed the inclination of the planetary orbit from the light of sight must be near 0^0. The transit appears periodically with a period equal to the revolution period of the planet and so an ephemeris can be deduced to predict future transits. The discovery of the "hot Jupiter" class of planets in 1995 dramatically improved the prospects of detecting exoplanets by looking for transits. For example, for WASP-3, transits recur approximately every 1.85 days (Gibson et al 2008).

In 2009 we received a Sigma Pi Sigma Undergraduate Research Award ($1800) from the American Institute of Physics to initiate an extrasolar transit program. We successfully showed that small (14-in) telescopes and affordable CCD cameras can be used to detect and measure extrasolar planetary transits. Results for WASP-3 are shown in Fig. 1. The errors in the depth of the transit, $\pm$ 0.7 millimag, and duration, $\pm$ 0.1 hr, are within the errors of accepted results from large telescopes (Gibson et al. 2008).

The main goal of the proposed work is to develop a strong research program in extrasolar planetary searches that involves undergraduates interested in STEM careers, provides methods and data for similar research at other universities, and is disseminated to larger audience of amateur astronomers nationwide.