WFIRST: Searching for Microlens Planets in Very Wide Orbits and the MOA Microlensing Data Release

Yuki Hirao, David Bennett, Takahiro Sumi

Abstract

Gravitational microlensing is an unique technique to detect exoplanets down to low mass planets beyond the snow line because It is sensitive to planets orbiting near the Einstein ring radius of a few AU away from its host star, which is complementary to other methods. Detecting such planets is important for understanding planet formation of our solar system because gas giants and ice giants planets are believed to be formed beyond the snow line, where the protoplanetary disk is cold enough for ice to condense, in the core accretion theory. Microlensing Observations in Astrophysics (MOA) group has conducted high cadence survey observations towards the Galactic bulge to detect exoplanets since 2006 at Mt.John University Observatory in NZ using MOA-II 1.8 meter telescope equipped with a very wide field-of-view MOA-cam3 CCD camera. MOA has alerted about 600 microlensing events every year and detected dozens of exoplanets in wide orbits. Future space telescope, *WFIRST,* will conduct survey observations towards the Galactic bulge and is expected to detect thousands of wide planets in wide orbits via microlensing to complete the census of exoplanets begun by *Kepler Space telescope,* which found planets in close orbits via transit method. To contribute to the *WFIRST* and make the microlensing community larger, MOA will open its data from 2006 to 2014 to the public. Through the off-line analysis, we have found some short binary events which were not detected in the real time analysis. Short-timescale microlensing events are important because they are candidates of free-floating or wide-separation planets. The poster will present the data release and some results of the analysis of short-timescale binary events.

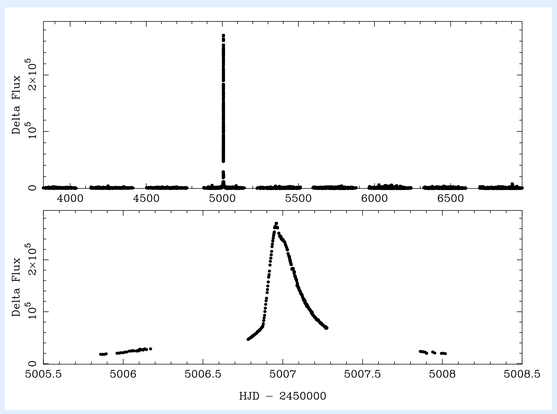
Background

MOA (Microlensing Observations in Astrophysics) Group is a Japanese, US, and New Zealand collaboration to detect exoplanets via microlensing. We have detected more than 50 planets by conducting high cadence observations towards the Galactic bulge since 2006 using MOA-II 1.8m telescope. WFIRST will also conduct survey observations and detect thousands of planets via microlensing. But the microlensing community is still small. So MOA will release the data for people to prepare for the WFIRST.

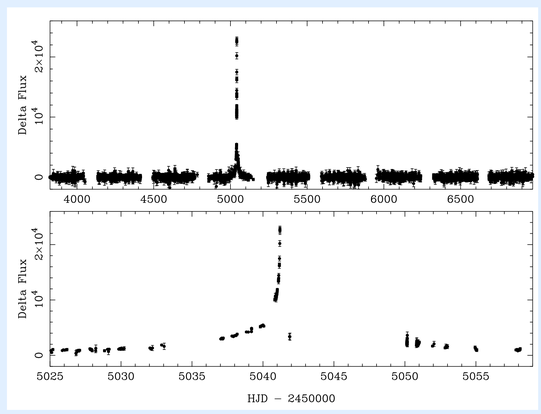
Above: MOA-II 1.8m telescope at Mt.John University Observatory in New Zealand

MOA Data Release

We are preparing for the release of the 2006-2014 MOA Galactic bulge data as part of the Japanese contribution to WFIRST. This dataset will be released late 2018 or 2019 at the latest. Through this offline analysis, we have found 6170 microlensing event candidates including 4305 events which were alerted in the real time analysis and listed on the MOA Alert page (https://www.massey.ac.nz/~iabond/moa/alerts/).



MOA-2009-BLG-319



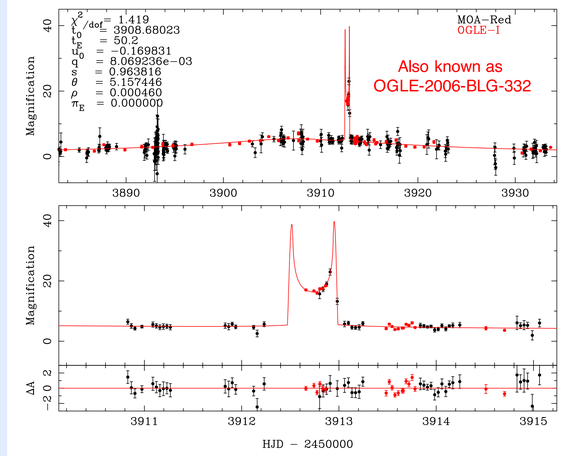
MOA-2009-BLG-387

Above: Light Curves of planetary microlensing events, MOA-2009-BLG-319 (left) (Miyake et al. 2011) and MOA-2009-BLG-387 (right) (Batista et al. 2011). The top panels show the whole part of the light curves and the bottom panels show a magnified part of the light curves.

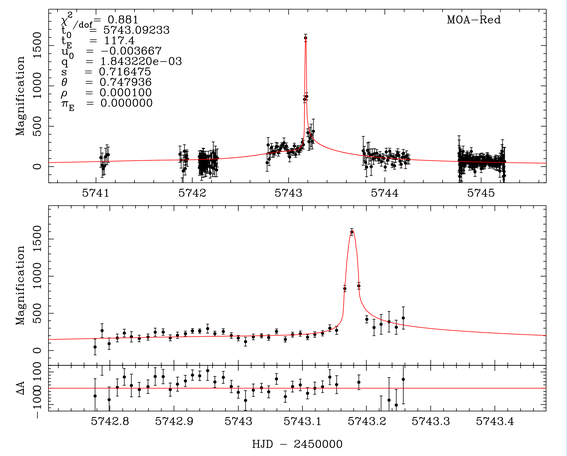
Modeling short binary events

Short binary events can be caused by very wide-separation planets. We have modeled the light curves of several such events that were recently discovered in the 2006-2014 data set. Here are some of these events, including two with a planetary mass ratio of $q < 0.03$.

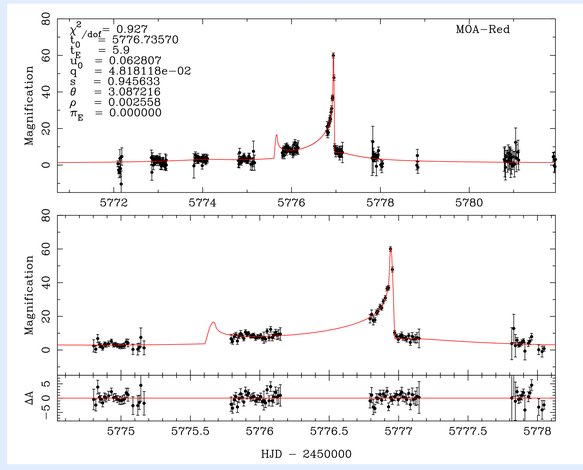
MOA-bin-17 planetary candidate



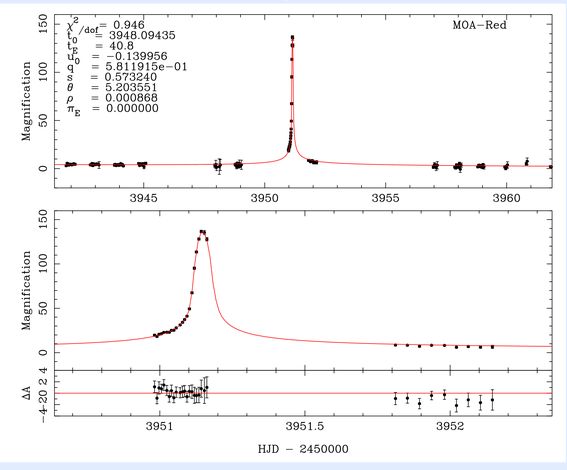
MOA-bin-41 planetary candidate



MOA-bin-21 binary or brown dwarf



MOA-bin-34 binary



Above: Light Curves of short binary microlensing events found by offline analysis. The top panels show the magnified part of the light curves, the middle panels show a close-up of the anomaly and the bottom panels show the residual from the best models.