Eric B. Ford
Penn State
ebf11 at psu.edu

Invited

Strategies for exploring parameter space for planetary microlensing events: Lessons from the RV and TTV community

When analyzing light curves with planetary microlensing events, the posterior probability density can have sharp features and/or multiple local maxima that may be widely separated in parameter space. Efficiently exploring such posteriors already poses a significant challenge for analysis of existing microlensing events, and thes echallenges will become more acute as the number of microlensing events increases. I will share some of the lessons learned from experience confronting related challenges when analyzing radial velocity and transit timing observations of multiple planet systems. Hopefully, this experience and the resulting discussion can help accelerate the microlensing community's effort to practical tools for Bayesian statistical modeling of microlensing events and planet populations.

Dan Foreman-Mackey
Associate Research Scientist
Flatiron Institute

Invited

Title: Using methods from machine learning and statistics as tools for data analysis in astronomy

Abstract: With the growing academic and industry interest in machine learning and statistics, there has been substantial investment in the development and implementation of high performance tools for model building and inference. Many data analysis problems in astrophysics can benefit from these developments, even if that isn't immediately obvious from the language in the literature. In this talk, I will demonstrate how tools designed for machine learning (for example, TensorFlow and PyTorch) can be used for defining probabilistic models for astrophysics, with a focus on photometric time series datasets. One major benefit of these tools is that they enable the use of gradient-based inference methods like Hamiltonian Monte Carlo that are much more efficient for high dimensional models than the more traditional methods used in astrophysics. I will discuss some specific use cases from my research to demonstrate the potential of these tools and discuss some possible applications for microlensing.

Ruth Murray-Clay
University of California, Santa Cruz
rmc@ucsc.edu

Invited

Planetary System Architectures as Probes of Planet Formation

The discovery of planets orbiting other stars has revolutionized the field of planet formation, demonstrating that classic models describing the origin of the Solar System are substantially incomplete. However, transit, radial velocity, and direct imaging techniques remain insensitive to regions of planetary phase space critical to understanding which physical processes dominate planet formation and orbital evolution. I will discuss several ways in which these processes may be constrained by the distribution of masses at wider orbital separations than currently probed. Using recent results from pebble accretion, constraints from direct imaging, and ideas about the dynamical redistribution of orbits, I will highlight the potential power of comparisons between orbital populations at different stellocentrc distances, even when the full architecture of each individual system cannot be measured.

Invited

NAME: Alessandro Sozzetti

AFFILIATION: INAF - Osservatorio Astrofisico di Torino

EMAIL: alessandro.sozzetti@inaf.it

TITLE: Gaia astrometry and exoplanets (in crowded fields too)

ABSTRACT: Gaia, ESA's global astrometry mission, is now in its fifth year of science operations at L2. I will describe the plans for astrometric orbit and mass determination with Gaia, and provide an update on the potential impact of Gaia results on exoplanetary science, in light of the latest understanding of the satellite's positional measurements precision. I will conclude touching upon the expectations for handling of very crowded fields (such as the Bulge) in future Gaia Data Releases.

Invited

Judit Szulágyi (ETH, Zurich)

Title: Formation of Intermediate Mass Giant Planets through Circumplanetary Disk Accretion

Abstract:
The traditional 1D core accretion scenario predicts that in the third and last phase of formation, the planets grow exponentially. In this stage their gaseous envelope collapse onto the core and this launches a runaway accretion of gas. If this were true, the implication is that there should be a dichotomy in the planet mass distribution: either planets do not enter the runaway phase and remain < 30 M_Earth or become several times more massive than Jupiter in a short time when entering the runaway phase. This is, however, in contrast with the observations. I carry out 3D radiative hydrodynamic simulations of planet formation, which reveals that a circumplanetary disk forms around the planetary core. This disk is limiting the accretion to the planet, first, because it breaks the spherical accretion, second, because it has low viscosity, and most importantly because the circumplanetary disk is heated up by the accretion process. As the planet vicinity is hot, the gas pressure grows and acts against accretion. This reduced accretion can explain the existence of the intermediate mass giant planets and the rareness of super-Jupiters.

Invited

Alice Zurlo
Universidad Diego Portales
alice.zurlo@mail.udp.cl

"Measuring the mass of Proxima Centauri from a microlensing event

Proxima Centauri, our closest neighbour, is a low mass M5 dwarf orbiting in a triple system. The mass of this star has been estimated only with mass-luminosity relations so far, which means that large uncertainties affect our knowledge on the proprieties of Proxima. Very recently an Earth mass planet with 11 days period has been discovered around Proxima Cen. To investigate on the mass of this star, an independent method has been proposed: taking advantage of the close passage of Proxima in front of two background stars, it is possible to parametrise the microlensing effect due to these close encounters and estimate the mass of the lens (Proxima) with high accuracy. The two microlensing events occurred in 2014 and 2016, with impact parameters of 16 ± 0.”1 and 0.”5 ± 0.”1, respectively. Accurate measurements of the background stars positions during the last two years have been taken with the Hubble Space Telescope, and with SPHERE at the Very Large Telescope from the ground. The SPHERE campaign started on March, 2015, and followed for more than two years, with 9 epochs taken. The parameters of Proxima motion on the sky, and the astrometric calibration of the instrument were readjusted using the background stars visible in the IRDIS field of view in each epoch. Here we present the analysis to measure the dynamical mass of Proxima Cen, and how we obtained sub-mas astrometry precision with SPHERE.

Fatima Abdurrahman - Graduate Student at UC Berkeley Department of Astronomy
fatima.abdurrahman@berkeley.edu
In collaboration with Haynes F. Stephens and Jessica R. Lu

Late-time high-resolution images of the black hole candidate microlensing events MACHO-96-BLG-5 and MACHO-98-BLG-6 (talk preferred)

Though stellar-mass black holes (BHs) are likely abundant in the Milky Way (N=10^8 - 10^9), only a few dozen have been detected to date, all in binary systems. Gravitational microlensing is a novel technique used to search for *isolated* BHs, of which there are no confirmed detections. Two microlensing events, MACHO-1996-BLG-5 (MB96-5) and MACHO-1998-BLG-6 (MB98-6), initially observed at closest approach in 1996 and 1998, (Bennet et al., 2002) have long durations (300-500 days), designating the lenses as candidate black holes. Unfortunately, photometric lensing alone cannot distinguish between a luminous lens and a BH. Now that ~20 years have elapsed, lens and source proper motions may have made the two objects resolvable. We attempt to further constrain the possibility of BH lenses by (1) using Keck infrared adaptive optics images to look for a now-resolved luminous lens; (2) examining broad-band photometry of the source, looking for flux contributions from a low luminosity lens; (3) utilizing Gaia and HST data to constrain the relative source-lens proper motions, eliminating regions of otherwise undetectable parameter space.
For either candidate, no new sources were detected within 0.3'' of the lensed source, implying either that the lens is dark (BH or brown dwarf) or that the proper motion is small. For MB96-5, we show that the lens must be a black hole, if it is at a distance >0.5 kpc and exhibiting proper motions >2.5 mas/yr. For MB98-6, a number of stellar lens scenarios are still allowed with masses from 0.08 - 2.0 solar masses at a distance >1 kpc and with proper motion >3 mas/yr, which require higher-contrast images to rule out.

Name
Fumio Abe

affiliation
Institute for Space-Earth Environmental Research, ISEE, Nagoya University

email address
abe@isee.nagoya-u.ac.jp

Title
Massive black hole search by MOA

abstract
Direct detection of gravitational wave by LIGO/Virgo showed rich population of massive black holes. The MOA collaboration has been accumulated data of bulge fields for microlensing search. We have started to analyse long term (2006-2014) bulge data to find massive black holes. Until now, we have selected long tE events and making parallax fits. I will report the progress of the analysis and preliminary results.

preference for talk or poster
Either

Rachel Akeson
Caltech/IPAC
rla@ipac.caltech.edu

Title: Community data products for the WIFRST Microlensing Survey

Abstract: The WFIRST mission will conduct a multi-year survey of the Galactic Bulge, spanning roughly 5 years over at least 6 campaigns. I will describe the plans to produce microlensing-specific data products for this survey, which range from light curves to catalogs of variable and microlensing sources. A microlensing pipeline will be operated at IPAC with contributions from the Science Investigation Team and made available to the community via the WFIRST archive. This data set will also facilitate many other areas of galactic science, including precision parallaxes, asteroseismology, black hole microlensing and exoplanet transits.

Prefer talk

Note that I submit two abstracts. One is for “my own work” and the second to present the soon submitted work of our LCO sutdent, D.Godines which can not attend the conference.

Name: Etienne Bachelet
Affiliation: Las Cumbres Observatory
Email address: etibachelet@gmail.com
Title :3 years of pyLIMA : status, presentation of results and future
Abstract:
I will present the status of the pyLIMA software after 3 years of implementation and testing. With the recent upgrade of VBBinaryLensing, pyLIMA is now fully operational for binary modeling . The code is already by the community and I will present results obtain for real events. I will conclude by underlining the future prospects for the development of the software.

Name: Etienne Bachelet
Poster
Affiliation: Las Cumbres Observatory
Email address: etibachelet@gmail.com
Title : A machine learning approach for microlensing detection in surveys : presentation of LIA
Abstract:
The detection of microlensing events in real time for large photometric surveys is a challenge for several reasons. First, the signal can mimic other transients and variables are early stage, such as flare or Mira stars. Second, the timescale and amplitude of microlensing events can vary significantly. Therefore, events detected as microlensing often require human judgement to be confirmed. Regarding the upcoming WFIRST and LSST experiments, it is necessary to explore new approaches to this problem.
I will present the LIA software developed by the LCO team to achieve this goal.

Name:
Fran Bartolić

Affiliation:
University of St Andrews

Email address:
fb90@st-andrews.ac.uk

Talk title:
Gaussian process models of correlated noise in microlensing lightcurves

Talk abstract:
I will discuss Bayesian approaches to modeling single-lens microlensing events, focusing in particular on different choices of parametrizations, priors for the model parameters, and different ways of modeling correlated noise using fast and scalable Gaussian Processes. The assumptions we make about the noise properties can have an important effect on the inferred physical parameters of interest, and Gaussian Processes are a particularly elegant class of nonparametric models for modeling time series data. Lessons learned from single-lens events can then be applied to the far more challenging problem of modeling multiple-lens events. I also plan to touch upon the challenges involved in sampling microlensing models with advanced MCMC algorithms such as Hamiltonian Monte Carlo.

Jean-Philippe Beaulieu

Title: Measuring masses thanks to KECK adaptive optics observations

Abstract:
Microlensing is probing the unique population of planets behind the snow line, distributed towards the Galactic Bulge. Although relative physical parameters are known to good precision from the modelling of the light curves, high angular res re an excellent route to ac systems. Using NIRC2 mounted on KECK we revisited over 30 planetary systems detected by microlensing. I will discuss the latest results about the cold planet mass determination and prospects for Euclid and WFIRST observations.

Aparna Bhattacharya

Contact: abhatta5@umd.edu

First Results from NASA Keck Key Strategic Mission Support

I will present the first results of NASA KSMS program with a near simultaneous observation between Keck and Hubble Space Telescope. We used HST and Keck simultaneously to do a preliminary study to develop a mass measurement method based on color dependent centroid shift. For OGLE-2012-BLG-0950 event, we measured the lens-source relative proper motion and confirmed the host star. We measured a 39 earth mass planet in the middle of the range 20-80 earth masses where the core accretion predicts a dearth of planets. Also there are several other events, like MOA-2008-BLG-379 that show the sign of detecting the lens host star.

Adaptive Optics follow-up of a super-Earth (OGLE-2017-BLG-1434) and a giant planet (MOA-2010-BLG-477)

Mr Joshua Blackman
School of Natural Sciences, University of Tasmania, Private Bag 37
Hobart, Tasmania 7001 Australia
joshua.blackman@utas.edu.au

High angular resolution observations are a superb tool that can be used to constrain the physical parameters of microlensing systems. I will present preliminary results of our Keck Adaptive Optics followup of the super-Earth object, OGLE-2017-BLG-1434 L,b. Wide K-band images were obtained with the NIRC2 Imager on Keck II in the 2018B observing season in order to constrain the K-band flux of the lens. I will discuss similar K and H-band data obtained on the giant planet event, MOA-2010-BLG-477 L,b.

I would prefer a talk.

Name: Valerio Bozza
Affiliation: Universit‡ di Salerno, Italy
E-mail: valboz@sa.infn.it
Title: "Multiple lensing with contour integration"
Abstract:
After the success of VBBinaryLensing as the fastest public code for binary microlensing computation, we aim at extending the methods developed therein to the case of multiple lensing. The complexity of the problem grows with n^2 and challenges the numerical precision. We will present some interesting innovations that may circumvent the main problems.

Name: Geoffrey Bryden
Affiliation: JPL
E-mail: bryden@jpl.nasa.gov
Title: Facing the Challenge of WFIRST: Machine Learning for Lightcurve Classification
Abstract: Machine learning offers an opportunity to analyze an arbitrarily large dataset in an efficient and statistically robust manner. While automated classification routines have been applied to astronomical surveys for decades, continual increases in the volume of data under consideration have motivated many recent applications. Application to microlensing survey data is particularly appropriate, not only for identification of a small number of interesting events within a large set of lightcurves, but also for calculation of the detection efficiency based on a set of simulated events. A pioneering effort to analyze OGLE data, for example, successfully identified more than a thousand events not detected by their early warning system (Wryzykowski+ 2015). Here we consider the application of machine learning to additional microlensing survey data, ranging from the relatively modest UKIRT dataset to high-quality simulated WFIRST lightcurves. By spanning a range of data quality, we identify lightcurve features that are most universal for classification and we assess how well learning from one environment transfers to another.

Sebastiano Calchi Novati

Title: Spitzer Opens New Path to Break Classic Degeneracy for Jupiter-mass Microlensing Planet OGLE-2017-BLG-1140Lb

Abstract:
I will discuss the microlensing planetary event OGLE-2017-BLG-1140Lb, which was observed simultaneously from ground and from Spitzer. These combined observations allowed us to measure the microlensing parallax and this turned out to be relevant for two reasons. Indeed, besides providing information on the physical parameters of the system, the microlensing parallax plays here a key role to break the binary-source-single-lens versus binary-lens-single-source degeneracy. As an additional reason of interest, OGLE-2017-BLG-1140Lb is a super-Jupiter-mass planet orbiting an M dwarf, beyond the system snow line and therefor adds up to the growing sample of similar systems detected by microlensing, a sample which remains a challenge for current planet-formation theories.

Microlensing 23 Abstract

Name: Andrew Cole
Affiliation: University of Tasmania
email: andrew.cole@utas.edu.au
Title: The 2018 Microlensing Season at UTAS Greenhill Observatory

Abstract: We give an overview of the instruments used and events tracked in 2018 from the University of Tasmania's 1.27-m telescope in central Tasmania. In 2018 we regularly observed remotely from a control room located on the University campus, from which we followed-up 52 microlensing events in the Galactic bulge and 1 in the Large Magellanic Cloud, across 76 nights. We have one full-time observatory staff member maintaining hardware and software systems, and two PhD students reducing and modelling light curves. From 2019 we will be looking for further improvements with the installation of a new primary mirror, and the development of an easily searchable archive of images and photometry.

[happy for either poster or talk]

William Dawson (LLNL)

Title: Strong and Weak Microlensing in the 2020's

Abstract:
I will present the methods of strong, i.e. resolved, and weak, i.e. correlated, gravitational microlensing. In addition to discussing the potential benefits of such methods, I will discuss the likelihood of being able to apply such methods in the 2020 era and beyond.

Where are the binary source gravitational microlensing events?

Martin Dominik

Centre for Exoplanet Science, SUPA School of Physics & Astronomy, University of St Andrews, North Haugh, St Andrews, KY16 9SS, United Kingdom

md35@st-andrews.ac.uk

Abstract

While many gravitational microlensing events have been reported to be caused by a binary lens, discussions of microlensing events as involving a binary source remain rare. Already 20 years ago I raised the question "Where are the binary source microlensing events?", but I will argue that we are still short of a comprehensive answer. Recent modelling of event OGLE-2014-BLG-1186 raised some further aspects, prompting a reassessment of this question.

Renata Frelikh
UC Santa Cruz
rfrelikh@ucsc.edu
Effects of a phase of planet-planet impacts on the population of outer giant exoplanets

I propose that systems with multiple giant exoplanets can be shaped by a phase of giant impacts. In this scenario, planet-planet collisions and scattering shape the inner (typically, ~10 AU) population of planets where collisional growth is likely to occur. This collisional growth region extends to a stellocentric distance where the escape velocity from the star drops to be comparable to the planetary escape velocity. Beyond that, collisions are less likely to occur, as there the planets are more likely to scatter bodies out of the system. If correct, our giant impacts phase will create a population of higher-mass planets out to the limit of the collisional growth region. Beyond that region, there will exist a population of lower-mass planets that avoided planet-planet mergers, some of which were scattered out on high-eccentricity orbits. Current microlensing surveys are sensitive to finding planets beyond the snow line (~2.7 AU) of a range of planet masses, from super-Earth masses to super-Jupiters, with sensitivity improving in future space-based missions such as WFIRST. If the mass separation predicted by our model is revealed in the outer giant exoplanet population as a result of these microlensing surveys, it will be indicative that certain exoplanetary systems undergo a phase of giant impacts.

Name: Akihiko Fukui
Affiliation: The University of Tokyo
Email address: afukui@eps.s.u-tokyo.ac.jp
Title:

Detailed Analysis of the Kojima Event: Anti-GB Planetary Event with the Brightest Host Star

Abstract:

The so-called Kojima event was a gravitational microlensing event discovered toward Taurus by an amateur astronomer, Mr. Kojima, in which a planetary feature was detected by prompt followup observations. In this contribution we show the result of detailed analysis of the photometric and spectroscopic followup data. We narrow down the physical parameters of the lens system, finding that the host star is a K/M dwarf located at 450 pc and the companion is a Neptune-mass planet located around the snow line of the system. We also calculate the detection efficiency of this planet in this event, which is about 30%. This may imply that Neptune-mass planets are abundant even around the snow line, where so far few planets have been discovered in all techniques.

Preferred presentation style: poster

Nathan Golovich (LLNL)

Title: MACHO Re-Analysis Results

Abstract:
For the past year I've been reanalyzing the MACHO data set for longer timescale events than the original search was sensitive to. I'll give an overview of our detection and dark matter constraint methods as well as give an early look at the preliminary results. Finally, I'll highlight our ongoing DECam microlensing survey (which may be much more exciting if our survey proposal is accepted in mid December).

Andrew Gould

KASI, MPIA, OSU

gould.34@osu.edu

Upgrades for KMTNet Alerts, Event-Finder, and Data Policy

Starting in 2019 KMT alerts will be available in real time for about 99% of the $97\,\mathrm{deg}^2$ area covered by KMT. Based the 2018 trial run of this system in the Northern Bulge, I give rough estimates of expected performance. I give instructions for obtaining rsynch access. The event-finder has been considerably upgraded, which enables both more efficient operation and sensitivity to much shorter events. I announce a new, expedited, data release policy, which will become effective as of the day of the talk.

Name: Calen B. Henderson

Affiliation: Caltech/IPAC-NExScI

Email Address: chenderson@ipac.caltech.edu

Title: Using Keck to explore microlensing degeneracies: The case of OGLE-2015-BLG-0966

Abstract:

Microlensing event OGLE-2015-BLG-0966/MOA-2015-BLG-281 (OB150966) was also observed with Spitzer, having initially been selected as a "secret" event but ultimately meeting criteria for selection as an "objective" event, in particular due to satisfying the "rising event" and "high magnification" metrics (cf. Yee+ 2015).
The ground-based light curve shows a clear deviation as the source passes over the tip of the central caustic, providing evidence for the presence of a second body --- a Neptune-mass planet (Street+ 2016).
However, the event suffers from both the close/wide degeneracy as well as the four-fold degeneracy that often accompanies satellite parallax observations.
Moreover, there exists bimodality with regard to the position of the source, which could reside in either the Galactic bulge or the Galactic disk.
Together these lead to an effective 16-fold degeneracy in the lens distance and planet-star separation.
Although the relative lens-source proper motion is a modest ~5 mas / year, the relative proximity of the lens system (~3 kpc) indicates that the flux of the lens host star could be constrained with large-aperture high-resolution facilities while it is yet blended with the source.
Here I will discuss preliminary results from a Key Strategic Mission Support Program (PI: Bennett) using NIRC2 on Keck designed to make lens flux measurements for a myriad of exoplanetary lens systems.
In particular, this specific test case of OB150966 emphasizes how a multi-modal solution space can be clarified with the aid of such high-resolution lens flux measurements.

Preference:

Talk

Abstract for 23rd International Microlensing Meeting

Name: Yuki Hirao

Affiliation: Osaka University / NASA GSFC

Email address: hirao@iral.ess.sci.osaka-u.ac.jp

Title: Unpublished binary and planetary events from MOA 9 year analysis

Abstract: The MOA Collaboration is releasing its 9 year retrospective 2006-2014 microlensing light curve data set to the public. In this data set, we have found dozens of unalerted microlensing events, which include unpublished binary and planetary event candidates. We conducted systematic light curve modeling of those events. This systematic modeling helps to find the degenerate solutions and are useful for future statistical studies for binary and planetary systems. In the talk, we present the analysis of one or more of those events included in the 9 year analysis.

Preference for talk or poster: talk

Name: Markus Hundertmark
Affiliation: Heidelberg University
Email address: markus.hundertmark@uni-heidelberg.de
Title: Planet detection and characterization with pyLIMA
Preference for talk.

Abstract:

The increasing number of smaller and larger microlensing surveys as well as the forthcoming WFIRST mission and its data-challenges motivate further work to instantaneously assess the planet detection probability as well as the ability to characterize binary and triple lens events. Recent improvements in the modelling of binary events including the upgrade of Valerio Bozza's binary model VBB as well as our insights from the WFIRST data challenge have led to ideas on how to use the pyLIMA open modeling code for achieving that in an efficient way. For that purpose, we have revisited the code that was used by the RoboNet team in the past, customized it for future challenges and tested it on microlensing events from the ROME/REA Key Project, which is currently running at the Las Cumbres Observatory (LCO) global network of robotic telescopes. In this talk, we will give an overview of the reasoning behind the code using a real-world example.

Samson A. Johnson

The Ohio State University

johnson.7080@osu.edu

The WFIRST microlensing survey: mission updates and predictions of the free-floating planet yield

The Wide Field Infrared Space Telescope (WFIRST) will perform a photometric survey of the Galactic bulge that will detect over 30,000 microlensing events, of which around 1400 will contain planetary perturbations. I will discuss the current mission design and how we are updating the simulations being used to predict the event rate. WFIRST will be able to detect short timescale events from free-floating planets (FFPs), as well as short timescale perturbations from bound planets, with its 15 minute cadence. I will present the predicted rate of FFP events and WFIRST's detection efficiency for these short timescale events.

Somayeh Khakpash

Lehigh University

Somayeh.khakpash@gmail.com

WFIRST: A Simple Approach for the Recovery of Planetary Parameters From Microlensing Light Curves

Microlensing is a powerful tool for discovering cold exoplanets, and the WFIRST microlensing survey will discover over 1000 such planets. The full modeling of each planetary microlensing event often requires significant investment of human and computing resources, and analyzing thousands of events found by large surveys is much more challenging. However, for a significant subset of microlensing events it may be possible to determine rough estimates of planetary parameters from a simple analytic light curve model. In this project, we examine thousands of simulated WFIRST light curves and investigate for what fraction of the events we can recover planetary parameters using this simple approach. We show that for systems with smaller planet/star mass ratios (10^-7 < q < 10^-5), we can determine the projected separation to about 5% accuracy, whereas for higher mass ratios (q > 0.001), we can determine it to about 40% accuracy. For systems with different ranges of projected separation, we can determine the mass ratio to about 60% accuracy in logarithmic units. Overall, this approach is more successful for microlensing planetary events caused by planetary caustics in a wide or close topology and when the mass ratio is lower.

This approach can conduct an initial fast analysis of WFIRST light curves to find approximate system parameters before investigating them thoroughly with other methods or to prioritize rapid follow-up observations, and is applicable to other large microlensing surveys.

Iona Kondo (Osaka University)

Title: Analysis of the short timescale planetary event MOA-bin-29

Abstract:
We report the analysis of the short timescale microlensing event MOA-bin-29 detected toward the Galactic bulge field. The event timescale is ~9 days. Thus the lens system could have a low mass host. Although we find some degeneracies from the light curve modeling, all these degenerated solutions have a planetary mass ratio. Since we don't measure a significant microlensing parallax, we estimate the physical parameters of the lens system by using a Bayesian analysis. We found that the system is likely a gas-giant planet around a brown dwarf in the Galactic bulge.

Name: Naoki Koshimoto

Affiliation: University of Tokyo

Email: koshimoto@astron.s.u-tokyo.ac.jp

Title: Evidence of systematic errors in Spitzer 2015 parallax measurements

Abstract:
The Spitzer microlensing campaign is a project which aims to reveal the Galactic distribution of planets. They measure microlens parallax for most events they observe by using the difference of line of sights between the Earth and Spitzer. However, although it is known that a large amount of systematic error often appears in the Spitzer light curves, it has been assumed that they do not affect the measured parallax values. In this work, we compare the 50 microlens parallax measurements from 2015 Spitzer campaign with the standard Galactic model by using Anderson-Darling (AD) test and Kolmogorov-Smirnov (KS) test. Galactic models used by three different groups are used for the tests and all of them indicate that the measured microlens parallax values are systematically larger than the model prediction. The AD and KS probabilities are both significantly small, $p_{AD} < 3.0 * 10^{-8}$ and $p_{KS} < 4.1 * 10^{-6}$, respectively. To make the model and measurements consistent, or to be $p_{AD} > 0.05$, the disk to bulge mass ratio needs to be 7.5 times larger than the original value, which is inconsistent with other observations of our galaxy. Our study implies systematic errors, which partly can be attributed to companions to the source or lens stars, on the parallax measurements by Spitzer microlensing campaign.

Preference for talk or poster: talk

Highlights from Gaia microlensing survey of the Galactic Plane

Katarzyna Kruszyńska[1], Łukasz Wyrzykowski[1], Krzysztof Rybicki[1], Paweł Zieliński[1], Mariusz Gromadzki[1], Mateusz Zieliński[1]

[1] Warsaw University Astronomical Observatory
kkruszynska@astrouw.edu.pl

Gaia is observing the whole sky since 2013 and has just been extended until at least 2020. Apart from delivering superb astrometric measurements for 1 billion of stars, it is also detecting on-going photometric transients. Among these almost 80 candidate microlensing events have been found from the bulge and the Galactic disk. Gaia light curves alone have on average a cadence of about 30 days. In order to better constrain the parameteres of the lenses we use ground-based follow-up provided by the network of telescopes, including SMARTS, REM, LCO and LT. The follow-up also includes spectral observations with VLT, Gemini and SALT in order to receive additional information on the source, including its distance. These spectra, obtained at different magnifications allow us to get an additional constrain on the blending parameter. They help identify non-lensing events, e.g., Be-type stars or CVs. Some of the Gaia events has been already observed also with Spitzer Space Telescope, in order to derive the parallax.

We will present the results and highlights of our work with Gaia Science Alerts, including most interesting events for which we have obtained both photometric and spectroscopic data.

Casey Lam
UC Berkeley
casey_lam@berkeley.edu
Title: PopSyCLE (Population Synthesis for Compact object Lensing Events)
Abstract: I will discuss a code we have been developing called PopSyCLE (Population Synthesis for Compact object Lensing Events), which models and calculates microlensing events in the Milky Way from first principles. PopSyCLE can be used to select black hole microlensing candidates from photometric surveys for astrometric follow-up. The simulation is resolved so there are positions, velocities, masses, and photometry for each star and compact object. PopSyCLE's unique strength is that we can easily modify the simulation inputs and model their impact on microlensing observables such as lens type, event duration, blend fraction, and magnification. As an example we consider how microlensing events observed with WFIRST differ from OGLE. We find that WFIRST's high spatial resolution will allow us to use blend fraction to select high-probability black hole candidates.
Preference: Talk

Shun-Sheng Li (National Astronomical Observatories of China)

Title: The application of asteroseismology and Gaussian processes to microlensing analysis

Abstract:
We present the analysis of the event OGLE-2017-BLG-1186 from the 2017 Spitzer microlensing campaign. This event is remarkable because its source is photometrically variable. We perform an asteroseismic analysis of the source star, and find it is an irregular variable red giant with average timescale of ~ 10 days. The asteroseismic analysis also provides us source properties including source angular size and distance which are essential for inferring lens properties. When fitting the light curve, we introduce Gaussian Processes (GPs) to make allowance for the correlated noise caused by the variable source. We note that this event is the first microlensing system in which asteroseismology and GPs have been used to account for the variable source.

Finding Stellar Mass Black Holes with Astrometric Microlensing

Jessica Lu (UC Berkeley)

We report on our search for stellar mass black holes using photometric and astrometric microlensing. We have observed 3 long-duration microlensing events selected from OGLE using the Keck Adaptive Optics system to provide precise astrometric measurements. Astrometry was obtained starting at the peak of the event and continuing for 3-4 years. We will present results for these candidates, including constraints on their masses and luminosities, and the probability that the lensing object was a black hole. Finally, we will discuss the prospects for astrometric microlensing with the next-generation of large ground-based telescopes and WFIRST.

The detection of two very low mass brown-dwarf binary systems with KMT/OGLE/Spitzer.

Amber Malpas / Michael Albrow

University of Canterbury

We will discuss our analysis of the microlensing events OGLE-2016-BLG-1266 and OGLE-2017-BLG-1038. Due to high cadence observations from KMTNet, both of these events have very well characterised binary lens solutions from combined ground based data. With the addition of Spitzer observations, we were able to measure the satellite parallax for the events, and hence determine their distances, orbital separations and masses. The lens systems in both events are comprised of a pair of very low-mass brown dwarfs, each with one component close to the deuterium fusion limit.

Name: Przemek Mróz
Affiliation: Warsaw University Observatory
Email: pmroz@astrouw.edu.pl
Title: Microlensing maps of the Galactic bulge and disk from OGLE-IV
Abstract:
The microlensing optical depth and event rate are tracers of the distribution of matter along the line-of-sight. I used the microlensing events detected by the OGLE-IV survey to create the largest and the most accurate microlensing optical depth maps of the Galactic bulge. For the first time, I also constructed the optical depth map of the full Galactic plane field that is observed by OGLE ($-170^{o}<l<+40^{o}$), which can provide the basis for future microlensing surveys of the Galactic plane. I will compare my observational results with the current knowledge of the structure and kinematics of the Milky Way and I will discuss other astrophysical applications of my optical depth maps.
Preference: talk

Name: Hiroko Niikura
affiliation: The University of Tokyo
email address: niikura@hep.phys.s.u-tokyo.ac.jp

Title:
New constraint on PBH abundance from microlensing observation of M31 with HSC

abstract:
We will report our updated result regarding dense cadence survey of Andromeda Galaxy (M31) to search for microlensing effects on stars in M31 due to primordial black hole (PBH), which is a viable candidate of dark matter. The Subaru Hyper Suprime-Cam (HSC) allows us to cover the entire bulge and disk regions with one pointing thanks to its wide field-of-view. In the last year's conference, we reported a constraint on the abundance of PBHs using a rough estimate of finite source size effect. Here we also take into account the effect of wave optics on the PBH constraint which weaken our PBH constraint in the mass $M_{¥rm PBH}¥le10^{-9}M_¥odot$. We will also report our new analysis of additional one-night microlensing observation performed in 2017 with HSC. This new data allows us to put tighter constraint on the PBH abundance, and also enables us to test the nature of one remaining microlensing candidate detected from previous observation in 2014.

preference for talk or poster: talk

Name: Matthew T. Penny
Affiliation: Ohio State University
Email: penny@astronomy.ohio-state.edu
Title: Microlensing Parallax Observations with CFHT: 2016, 2018, and beyond

Abstract:
Our group has conducted microlensing campaigns in 2016 and 2018 to support microlensing parallax measurements with K2 Campaign 9, and Spitzer. I will begin by reporting on the status of the analysis of these data sets, and suggestions of how they can contribute to the analysis of many microlensing events. In 2019 and 2020 we will conduct further CFHT campaigns, but focused instead on measuring annual parallax in faint events. These campaigns will take advantage of CFHT's excellent image quality and queue mode to use tiny amounts of telescope time to gather precise photometry in the faint wings of microlensing events and add significant value to the observations of the main microlensing surveys.

Radek Poleski (Ohio State University)

Title: K2 Campaign 9 data analysis and planetary event OGLE-2016-BLG-0241

Abstract:
I will present the analysis of the K2C9 planet OGLE-2016-BLG-0241Lb. The ground-based data consist of: OGLE, KMT, MOA, CFHT, Wise, UKIRT, Danish, LCOGT, VST, DECam, and SkyMapper datasets. I'll present MCPM method that was developed to reduce the K2C9 data and how it performs on OGLE-2016-BLG-0241 and some other events.

First name: Clement
Last name: Ranc
Affiliation: USRA/NASA Goddard Space Flight Center
Email address: clement.ranc@nasa.gov

Title: OGLE-2006-BLG-332: First New Planetary Event from the 9-year Retrospective Analysis of MOA survey

Abstract:

As the detection efficiency is often much higher during a retrospective analysis than a real-time alert process, MOA is conducting a systematic analysis of the high-cadence MOA-2 survey observations starting from 2006. I will present the analysis OGLE-2006-BLG-332/MOA-bin-17, the first new planetary event from this 9-year retrospective analysis, for which high-resolution images have been obtained. The mass ratio for this event is q~8E-3, but models with higher values are not ruled out at this stage. This is mainly due to the lack of follow-up observations during the caustic entry. Similarly, some events from this large sample are subject to parameter degeneracies. The well-known wide/small separation degeneracy is one example, but there may also be ambiguities about the nature of the lenses. The wider the distance between modes, the harder it is for a Markov Chains Monte Carlo (MCMC) algorithm to jump between them, and therefore sample the full posterior distribution. However, the relative probability between modes is often crucial to conclude about the nature of the lens. There can be planets in different locations or cusp approaches that look nearly identical for a planet-star or binary-star model. One widespread method to assess the relative probability between different modes consists in weighting the solutions by the corresponding best chi-square. While this approach seems reasonable in cases where the likelihood surface in the parameter space has a similar shape or volume in the vicinity of each solution, very different modes may lead to improper conclusions. Optimized MCMC algorithms are designed to jump between different modes widely separated in the parameter space when a single Metropolis-Hastings algorithm is not suited because their acceptance rates become too low. Statisticians are still developing such MCMC algorithms which can effectively sample multimodal likelihood parameter spaces. I will compare the sampling efficiency and the posterior distribution resulting from diverse sampling methods by testing them on the light-curve modeling of several events, including OGLE-2006-BLG-332 and MOA-bin-29.

Preference for talk or poster: talk

Kris Rybicki

Warsaw University Astronomical Observatory

krybicki@astrouw.edu.pl

title: Astrometric microlensing in the era of Gaia and WFIRST

Although more than 2000 microlensing events are being detected every year, in the vast majority of cases the physical parameters of the lens cannot be determined. The most problematic parameter is the Einstein Radius, which can only be determined for the caustic crossing/high magnification events or after many years after the event. A very promising channel to obtain Einstein radius more routinely is astrometric microlensing. Unfortunately, the astrometric effect is very small - there are successful attempts to use interferometric ground-based facilities but this can only be done for a very small, selected sample of candidates. We investigate the potential capabilities of the Gaia and WFIRST satellites in the context of astrometric microlensing and lens mass measurements. We simulate astrometric time series that will be obtained using these satellites and try to answer the question if it will be capable of measuring masses of lenses and how many astrometric events can we expect to detect.

We also use Gaia DR2 astrometry and compare it to OGLE catalogues to predict future microlensing events and find missed archival events in the Galactic Center. For archival microlensing events that taken place 10-15 years ago and were detected in the OGLE-III project, one can expect, that projected separation of the source and the lens is high enough to identify them as different objects if their relative proper motion was relatively high. Knowing that, we will examine Gaia DR2 catalogue and search for high proper motions stars, to potentially find objects involved in microlensing events in the past. It would provide, similarly to the case of observing predicted events, otherwise unobtainable knowledge about the lens, including its mass.

preference for talk

Title: Astrometric Microlensing with HST
Authors: Kailash C. Sahu (STScI) et al.
Abstract: We have several astrometric microlensing projects currently under way using HST, which include (i) determining the masses of nearby stars, and (ii) detecting and measuring the masses of stellar and intermediate-mass black holes. This talk will provide a summary and current status of these projects.

Characterizing Free-Floating Planet Candidates from K2C9

Yutong Shan, Jennifer Yee, Wei Zhu, Chelsea Huang

Properties of the free-floating planet (FFP) population shed critical insights to planet formation and dynamical evolution models. Ground-based microlensing surveys have hinted at a large population of free-floating planets, but their nature is intensely debated, largely due to the fact that individual FFPs are difficult to characterize from the ground alone. In conjunction with ground-based observations, K2 Campaign 9 (K2C9) is able to measure physical properties of isolated low-mass field objects using the satellite parallax effect. We will present results from the characterization of several FFP candidates in K2C9.

IN-GU SHIN[†]

[†]**Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138, USA**
(in.gu-shin@cfa.harvard.edu)

Degeneracies in Discoveries of Microlensing Planet Candidates by the KMTNet Survey in 2017

The KMTNet has discovered several planet candidates during 2017 bulge season. Among them, I report two microlensing events with planet candidates: KMT-2017-BLG-0962 and KMT-2017-BLG-1119. These events show relatively low mass ratios (~0.01 and ~0.06, respectively), which imply that the companions of the lens star are planets. However, both events have severe degenerate solutions caused by the close/wide degeneracy. Moreover, light curves of both events can also be well described by a binary-source with a single lens. Thus, both discoveries remain planet candidates.

Name: Yossi Shvartzvald

Affiliation: Caltech

Email address: yossishv@gmail.com

Title: The Galactic Distribution of Planets via Spitzer Microlensing Campaigns

Abstract:
During 2014–2018 seasons we followed with Spitzer over 700 microlensing events that were discovered and monitored simultaneously by ground-based surveys. The main objective of the Spitzer campaigns is to determine the Galactic distribution of planets, by systematically measuring the microlens parallaxes. An estimate of the Galactic distribution of planets, in particular the relative frequency of planets in the Galactic bulge versus disk, is important for understanding planet formation in different Galactic environments. In this talk I will review the current status of the project, focusing on results from the 2018 season. I will also discuss our plans for the final Spitzer campaign, in 2019.

Name : Jan Skowron
affiliation : Warsaw University Observatory
email address : jskowron@astrouw.edu.pl
Title : OGLE in 2018 and 2019
preference : for talk
abstract :
News and updates on the OGLE Project and on planned endeavors for the next
Galactic bulge season will be presented. I will mention our on-going work
on the characterization of long-time-scale events seen in all OGLE phases.
I will also introduce new fields in the Milky Way disk and in the greater
Galactic bulge region that are recently monitored by the OGLE Project.

Results of the first Microlensing Data Challenge

R.A. Street, WFIRST MicroSIT Team and Challenge Participants

Last year, we announced the first Microlensing Data Challenge, with the goals of stimulating research into the outstanding challenges presented by the analysis of events, and bring new people and skills into the field. Teams were challenged to fit models to dataset of several hundred lightcurves simulated with WFIRST-like observing cadence and photometry. I will summarize the results of the entries, and examine the strengths and weaknesses revealed by a comparison with the original simulated parameters.

Name: Takahiro Sumi
Affiliation: Osaka University
Email: sumi@ess.sci.osaka-u.ac.jp

Titel: PRIME

Abstract:
We report the status of the NIR microlensing exoplanet search project, the Prime-focus Infrared Microlensing Experiment (PRIME).
We are building a new 1.8m wide field infrared telescope at the Sutherland in South Africa.
One of the largest NIR camera will be build by using four H4RG-10 detectors loaned from the WFIRST project.
Thanks to 1.3 deg.^2 FOV, we can conduct the first high cadence microlensing survey in H-band
towards the central region of the galactic bulge, where high dust extinction prevents optical observations.
Because the stellar density is higher at the lower galactic latitude, we expect higher event rate.
We can compare the planet abundances in high and low stellar density for the first time,
which is important for the study of the planetary formation scenarios.
The event rate map produced by PRIME can be used to optimize the WFIRST observing fields.
If the PRIME telescope and WFIRST observe the same fields simultaneously,
different light curves will be observed due to the different line of sights, so-called the space-based
microlensing parallax. This enables us to measure the mass and the distance of the lens system
and enhance the WFIRST’s yields.

Name: Daisuke Suzuki
Affiliation: ISAS/JAXA
Email: dsuzuki@ir.isas.jaxa.jp

Talk or poster: I prefer talk for my presentation.

Title: MOA-2018-BLG-199/KMT-2018-BLG-0359Lb: A super-Jupiter around an M-dwarf host

Abstract:
A microlensing event, MOA-2018-BLG-199/KMT-2018-BLG-0359 was independently discovered by two survey teams, the MOA and KMTNet collaboration. The light curve data of this event shows a long magnification through the 2018 season as well as a short time brightening episode just after the peak of the primary magnification.
We fit the light curve data with the binary model and found that the best fit model shows the mass-ratio of ~0.01 with likely detections of both the microlensing parallax and finite source effects, which yields the host star mass of ~0.4 M_{Sun} and planet mass of ~4 M_{Jup}. Therefore, the lens system is another case of a super-Jupiter planet around an M-dwarf host. This result strongly supports the possible Jupiter desert around M dwarfs (e.g., Fukui et al. 2015). In this presentation, we report the analysis of this event and discuss our result.

Name: Yiannis Tsapras
Affiliation: Heidelberg University
Email address: ytsapras@ari.uni-heidelberg.de
Title: The ROME/REA LCO Key Project update
Abstract: The ROME/REA Key Project is the largest science project currently running at the Las Cumbres Observatory (LCO) global network of robotic telescopes. Using LCO's 1-m southern telescope network, we perform daily monitoring of a ~4 sq. deg. area where the microlensing event rate is highest. Responsive follow-up observations self-trigger whenever microlensing targets are highly magnified or display anomalous features. Observations are carried out in three bands (SDSS-i',r' and g') in an automated fashion. Multi-band photometry for about three million stars in the area surveyed will be publicly released at the end of the project. I will talk about the current status of the project and give an overview of its 2nd season of operations.

Mass-gap black holes from OGLE and Gaia

Łukasz Wyrzykowski[1]

[1] Warsaw University Astronomical Observatory
lw@astrouw.edu.pl

The distribution of masses of stellar remnants observed in X-ray binaries exhibits a clear mass-gap between 3 and 5 Solar masses. I will present microlensing candidates for dark lenses identified in the OGLE-III survey, for which the masses and distances were estimated based on the annual parallax signal and Gaia DR2 measurements of proper motion of the lensed sources. The distribution of masses of these dark lenses hint a continuum of masses between neutron stars and black holes. I will also present the on-going hunt for microlensing black holes with Gaia and discuss the future prospects for the LSST.

Weicheng Zang (Tsinghua University)

Title: LCO follow-up for Spitzer and KMTNet events

Abstract:
LCO follow-up project aims to densely observe HM events and anomalous events using LCO 1m and 0.4m telescopes. I will introduce the strategy for the follow-up observations and the results in 2018. Particularly, I will report the analysis of Spitzer planetary event OGLE-2018-BLG-0799, which is likely a massive planets in the Galactic bulge.

Name: Wei Zhu
Affiliation: Canadian Institute for Theoretical Astrophysics (CITA)
Email: weizhu@cita.utoronto.ca
Title: A pair of planets likely in mean motion resonance from gravitational microlensing
Abstract:
OGLE-2012-BLG-0026L is the second two-planet system found by microlensing. The two giant planets both lie very close to the Einstein ring, and they are not aligned (or anti-aligned) with respect to the host star. These features suggest that the two planets are also very likely closely spaced after deprojection. Combined with dynamical analysis and theoretical argument, I show that the two planets are likely in mean motion resonance. This work points out a new method to constrain the 3D orbital configuration of multi-planet systems from microlensing.

Poster

** This is for poster presentation

Spitzer Microlensing of MOA-2016-BLG-231L : A Counter-Rotating Brown Dwarf Binary in the Galactic Disk

Sun-Ju Chung[1]
KMTNet/OGLE/MOA collaborations

[1] Korea Astronomy and Space Science Institute(KASI), sjchung@kasi.re.kr

Abstract

We analyze the binary microlensing event MOA-2016-BLG-231, which was observed from the ground and from *Spitzer*. The lens is composed of very low-mass brown dwarfs (BDs) with M_1 = 21^{+12}_{-5} M_J and M_2 = 9^{+5}_{-2} M_J, and it is located in the Galactic disk D_L = 2.85^{+0.88}_{-0.50} kpc. This is the fifth binary brown dwarf discovered by microlensing, and the BD binary is moving counter to the orbital motion of disk stars. Constraints on the lens physical properties come from late time, non-caustic-crossing features of the *Spitzer* light curve. Thus, MOA-2016-BLG-231 shows how *Spitzer* plays a crucial role in resolving the nature of BDs in binary BD events with short timescale (<~ 10days).

Poster

Lisa Dang

Title: Detrending Spitzer Microlensing Campaign Light Curves using Pixel Level Decorrelation

Abstract:
In recent years, the Infrared Array Camera (IRAC) on the Spitzer Space Telescope has been given a new role as microlens parallax satellite. Over the past decade, IRAC has been notoriously known for its contribution to the study of transiting planets and their atmospheres. These investigations require high photometric precision leading to the development of a multitude of photometric techniques. We test the applicability of Pixel Level Decorrelation to detrend instrumental effects from microlensing signals. We present the performance of this technique on time series photometry of microlensing events obtained from the Spitzer Microlensing Campaign.

Poster preferred

Poster

Name : Roberto Jose Figuera Jaimes
Affiliation : University of Tsinghua
Email address: robertofiguera@gmail.com
Title : Photometry for RoboNet/LCO fields observed in 2016
Abstract : Every year the RoboNet collaboration, using Las Cumbres Observatory Network, has monitored microlensing events detected by OGLE and MOA surveys with the aim of discovering extrasolar planets. Several thousands of images have been taken along every year not only for the microlensing events but for all stars in the fields observed which are about 26'x26' with a pixel scale of 0.389".

Considering that observations are done toward the Bulge of the Milky Way, the fields observed are highly crowded with even more than 100000 stars detected on the images making the reduction processes for the whole fields far from trivial as there will be blending and saturated stars which can affect the photometry of their neighbour stars. Due to this, to do a proper photometry extraction for all stars is important to use the most sophisticated reduction procedures such as difference image analysis.

We report the status of our reductions for observations taken in 2016 using the DanDIA pipeline in ~20000 images in the field of ~60 microlensing events.

Poster

Determining the NIR Microlensing Event Rate at $|b| < 2$ with the United Kingdom Infrared Survey Telescope

Savannah R. Jacklin[1], Yossi Shvartzvald[2], Geoff Bryden[3], Sebastiano Calchi Novati[2], Keivan G. Stassun[1,4]

[1] Department of Physics and Astronomy, Vanderbilt University, Nashville, TN 37235, USA
[2] IPAC, MS 100-22, Caltech, 1200 E. California Blvd., Pasadena, CA 91125, USA
[3] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA
[4] Department of Physics, Fisk University, Nashville, TN 37208, USA

With the mid-2020s launch of the Wide Field Infrared Survey Telescope (WFIRST) fast approaching, it is becoming increasingly imperative to understand the optimal spatial region for microlensing event detection. The Galactic center (i.e. where $|b| < 2$) which has the highest density of potential source stars in the Milky Way, has been historically understudied due to the obscuring properties of its high volume of gas and dust. The United Kingdom Infrared Survey Telescope (UKIRT) microlensing project has succeed in mitigating some of the reddening effect of Galactic dust by observing in the near-infrared over a baseline from 2015-2018. Observations in the K and H NIR bands in unique fields have yielded hundreds of microlensing events detected via our UKIRT data reduction pipeline. We combine our microlensing detections with image-level mock event injections in order to determine our survey's detection efficiency, and subsequently aim to derive the NIR microlensing event rate per observed square degree. Here we discuss the methodology of our pipeline as well as preliminary results for the NIR microlensing detection efficiency and event rate. Understanding the intrinsic NIR microlensing event rate at low Galactic latitude is crucial for informing mission design and field specifications for WFIRST.

NOTE: This abstract is best suited to a poster

Poster

・Name Haruno Suematsu
・Affiliation Osaka University
・email address suematsu@iral.ess.sci.osaka-u.ac.jp

・Title

Classifying Difference Image Analysis (DIA) images by using Deep Learning

・abstract

We present a system to classify Difference Image Analysis (DIA) images by using Deep Learning. It is often the case that a new object found by DIA is not a real star, but a dust, saturation effect, etc. Thus, visual investigation of the DIA images is needed, although this is not efficient to check thousands of objects. Therefore, as a first step, we built a system to automatically classify whether a new object in the DIA images is a star or not by using Convolutional Neural Network (CNN), which is a technology for classification of visual inputs. The developed system can correctly classify ~88% objects. In order to apply the system to observation, it is necessary to reduce false negative rate.

・preference for **poster**