Glossary of Microlensing Terms

Single lens parameters | Binary Lens Parameters | Photometric Parameters | Key Concepts | Naming Convention

Although microlensing incorporates a fairly large number of parameters, most events can be understood quite intuitively. This glossary is intended as a quick reference, particularly to disambiguate the different symbol sets used by different authors over time. Interested readers are referred to the references at the bottom for a full discussion, especially Skowron et al. (2011), and to the Learning Resources menu.

Name	Commonly-used symbols	Unit	Definition
Single Lens Parameters			
Einstein crossing time	t_E	days	Time taken for the background source to cross the lens' Einstein radius, as seen by the observer. Caution: some early microlensing papers may refer to t_E as the crossing time for the lens' Einstein diameter.
Time of peak	t_0	days	Time at which the separation of lens and source reaches the minimum.
Source self-crossing time	t_*	days	Time taken to cross the source's angular radius $$t_* \equiv \rho t_{\rm E}$$
Impact parameter	u, at minimum u_0	Dimensionless	The angular separation, normalized to θ_E, between source and lens as seen by the observer Conventionally u_0 is positive when the lens passes to the right of the source star (Gould et al. 2004)
Effective timescale	t_{eff}	days	Equal to $u_0 t_E$
Rho	ρ	Dimensionless	The angular source size θ_S normalized by the angular Einstein radius θ_E
Vector Microlens Parallax (also: annual parallax)	**π** or $\bar{\pi}$, components ($\pi_{E,E}$, $\pi_{E,N}$) or ($\pi_{E,\parallel}$, $\pi_{E,\perp}$)		The parallax to a lensing event caused by the motion of the Earth in its orbit during the event. $$\bar{\pi}_{\rm E} = (\pi_{{\rm E},\parallel}, \pi_{{\rm E},\perp})$$
	($\pi_{E,N}$,$\pi_{E,E}$)		$$\bar{\pi}_{\rm E} \equiv (\pi_{\rm E,N}, \pi_{\rm E,E}) \equiv (\cos\phi_\pi, \sin\phi_\pi)\pi_{\rm E},\ \text{where}\ \pi_{\rm E} = {\rm AU}/\tilde{r}_{\rm E}$$
	($\pi_{E,\parallel}$, $\pi_{E,\perp}$)		Components of parallax parallel and perpendicular to the apparent acceleration of the Sun, projected on the sky in a right-handed convention (Gould et al. 2004) $$\bar{\pi}_{\rm E} = (\pi_{{\rm E},\parallel}, \pi_{{\rm E},\perp})$$
Direction of lens motion	ϕ_π	radians	The direction of lens motion relative to the source expressed as a counter-clockwise angle, north through east
Relative parallax	π_{rel}		Relative parallax observed for lens and source $$\pi_{rel} = \theta_{\rm E}\pi_{\rm E}$$
Source parallax	π_S		Parallax of the source star as seen from Earth
Lens distance	D_L	pc	Physical distance from the observer to the lensing object.
Source distance	D_S	pc	Physical distance from the observer to the source star.
Lens-source distance	D_{LS}	pc	Physical distance between the source and lens along the observer's line of sight.
Lens mass	M_L	$M_\odot$	Mass of the lensing object, including all component masses unless otherwise stated.
Kappa	κ		Commonly used to abbreviate equations for the mass of the lens, kappa gathers together all the physical constants in the equation: $$\kappa = \frac{4G}{c^2 AU}$$
Einstein angular radius	θ_E	mas	The angle subtended by the Einstein radius of a lens from the distance of the observer.
Source angular radius	θ_* or θ_S	mas	The angle subtended by the source star radius at the distance of the observer
Einstein radius	R_E	Km	The characteristic radius around the lens at which the images of the source form due to the gravitational deflection of light.
Projected Einstein radius	$\tilde{r}_E$	Km	The Einstein radius projected to the observer's plane.
Source radius	R_* or R_S	Km	The physical radius of the source star
Helio- and geocentric proper motions	μ_{helio} and μ_{geo}	mas/yr	Proper motion of the source star relative to the Sun and Earth, respectively $$\bar{\mu}_{geo} = \mu\bar{\pi}_{\rm E}/\pi_{\rm E}$$
Binary Lens Parameters			
Parameter reference time	$t_{0,par}$	days	The reference instant at which all parameters are measured in a geocentric frame that is at rest relative to the Earth at that time (An et al. 2002)
Fiducial time	$t_{0,kep}$	days	Fiducial time specified during analysis of binary lens events. In general $t_{0,kep}$ and $t_{0,par}$ are defined to be equivalent
Lens masses	$M_{1,2,P \text{ or } S}$	$M_\odot$ unless otherwise stated	Most generically, the massive components of the lensing system are refered to as "M_1" or "M_P" for the primary or largest mass object and "M_2" or "M_S" for the secondary. In cases of a planet-star binary however, M_P is sometimes used to refer to the planet (i.e. secondary) while M_S may refer to the star (primary)
Mass ratio	q		The ratio of the masses of a binary lens, $$M_2/M_1$$
Mass fraction	ε		The ratio of the one of the masses in a binary lens to the total mass of that lens, $$M_i/M_{tot}$$
Lens separation	s, also s_0, d or b	Dimensionless	The projected separation of the masses of a binary lens during the event, normalized by the angular Einstein radius θ_E
Projected lens separation	$a_\perp$	AU	Projected separation of binary lens masses in physical units.
Angle of lens motion	α also α_0	radians	Angle (counter-clockwise) between the trajectory of the source and the axis of a binary lens, which is oriented pointing from the primary towards the secondary
Rate of change of lens separation	ds/dt	θ_E/year	The change in the projected separation of a binary lens due to the motion of the lens components in their orbit during an event
Rate of change of trajectory angle	dα/dt	radians/year	The change in the trajectory of the source relative to the axis of a binary lens, due to the orbital motion of the lens components during an event.
Earth orbital velocity	$\mathbf{v}_{\oplus,\perp}$	km/s	The component of Earth's velocity at $t_{0,par}$ projected onto the plane of the sky
Binary lens orbital velocity	**γ** or $\bar{\gamma}$, components ($\gamma_\parallel$,$\gamma_\perp$,γ_z)		Components of the velocity of the secondary lens relative to the primary due to orbital motion at time $t_{0,kep}$ $$\gamma_\parallel = (ds/dt)/s_0,$$ $$\gamma_\perp = -d\alpha/dt$$ γ_z is measured only in rare cases where the full Keplerian orbit can be determined (see Skowron et al. 2011), but is oriented such that positive γ_z points towards the observer
Binary lens orbital position	Components (s,0,s_z)		Components of the position of the secondary lens relative to the primary due to orbital motion at time $t_{0,kep}$ The "perpendicular" component is always zero because the coordinate system is orientated with one axis along the binary axis.
Projected orbital velocity	**Δv**		Projected physical orbital velocity of the secondary of a binary lens relative to the primary $$\bar{\Delta}v = D_L\theta_{\rm E}s\bar{\gamma}$$
Projected orbital position	**Δr**		Projected physical orbital position of the secondary of a binary lens relative to the primary $$\bar{\Delta}r = D_L\theta_{\rm E}(s, 0, s_z)$$
Lens plane coordinates	(ξ,η)	Normalized to θ_E	Coordinate system in the plane of a binary lens, parallel and perpendicular to the binary axis respectively
Orbital energy	$E_{\perp,kin}$,$E_{\perp,pot}$		The projected kinetic and potential energy due to binary lens orbital motion (Batista et al. 2011) $$\frac{E_{\perp,kin}}{E_{\perp,pot}} = \frac{\kappa M_\odot \pi_{\rm E}(\lvert\bar{\gamma}\rvert yr)^2 s^3}{8\pi^2\theta_{\rm E}(\pi_{\rm E} + \pi_S/\theta_{\rm E})^2}$$
Photometric Parameters			
Magnification	A, at peak A_{max} or A_0		The magnification of the source star flux caused by the gravitational lens.
Event flux	f(t,k)	counts/s	The total flux measured during a lensing event as a function of time, t, is the combination of the flux from the source being lensed plus the flux from (unlensed) background stars. Since different instruments, k, have different pixel scales and hence different degrees of blending, these are characterized with separate parameters. Commonly defined as: $$f(t,k) = A(t)f_S(k) + f_b(k)$$
Source flux	f_S	counts/s	Flux received from the source (as opposed to f_b)
Blend flux	f_b	counts/s	Flux from background sources blended with the source.
Blend ratio	g		Ratio of blend flux to source flux
Baseline magnitude	I_{base} or I_0	mag	The measured brightness of a source star when unlensed, which may be blended with other stars
Peak magnitude	I_{peak}	mag	Measured brightness of the source star at the time of smallest separation between lens and source, i.e. greatest brightness
Source magnitude	I_S	mag	Measured (and reddened) source star magnitude
Dereddened source magnitude	$I_{S,0}$	mag	Source star magnitude when corrected for interstellar reddening
Blend magnitude	I_B	mag	Measured magnitude of stars blended with the source star
Lens magnitude	I_L,H_L	mag	Magnitude of the lens star measured in I and H passbands
Source star color	Usually $(V-I)_S$	mag	Measured color (here in (V-I) bands) of the blended and reddened source star
Dereddened source color	Usually $(V-I)_{S,0}$	mag	Dereddened color of the source star
Blend color	Usually $(V-I)_B$	mag	The combined color of stars blended with the source
Extinction coefficient	Usually A_I	mag	Extinction between the observer and the source star, here in the I passband
Reddening cofficient	Usually E(V-I)	mag	Reddening term between the observer and the source, here in the V and I passbands
Limb darkening coefficient	Γ_λ	mag	Limb darkening coefficient for passband λ (An et al. 2002)
Limb darkening coefficient	u_λ	mag	Limb darkening coefficient for passband λ
Key Concepts			
Optical depth	τ	$star^{-1}$	The probability that a given star, at a specific instant in time, has an magnification caused by gravitational microlensing of A > 1.34. This is the fraction of a given solid angle of sky observed which is covered by the Einstein rings of all lensing objects within that area.
Event rate	Γ	$star^{-1}\ yr^{-1}$	The rate at which microlensing occurs.

Naming Convention

Microlensing events are usually named for the survey which independently discovered them, the year in which they were discovered and the region of the sky in which they were found.
For example: OGLE-2017-BLG-1234 refers to the 1234th event found by the OGLE survey in the Galactic Bulge during the 2017 observing season.
As most microlensing events are found in largely the same region of the Galactic Bulge, it is often the case that multiple surveys will find the same event independently. In these cases, it is customary for the event to be refered to by a joint name, in the sequence in which public alerts were issued.
For example: OGLE-2017-BLG-1234/MOA-2017-BLG-234 indicates that OGLE issued a public alert first, and MOA subsequently found the same event independently.

References:

An et al. (2002), MNRAS, 572, 521
Skowron et al. (2011), ApJ, 738, 87
Gould, A. (2000), ApJ, 542, 785
Gould et al. (2004), ApJ, 614, 404
Batista et al. (2011), A&A, 529, 102