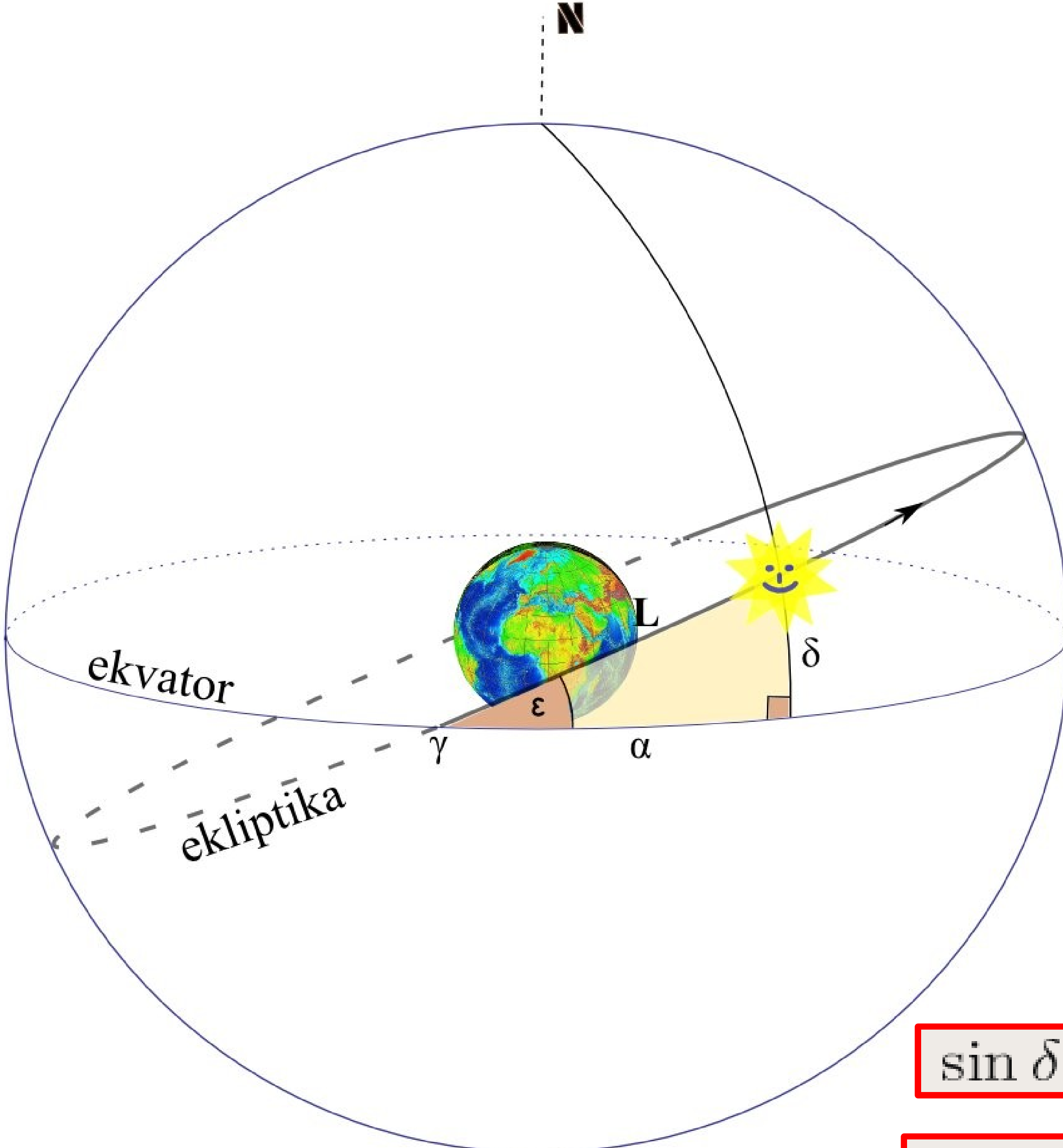
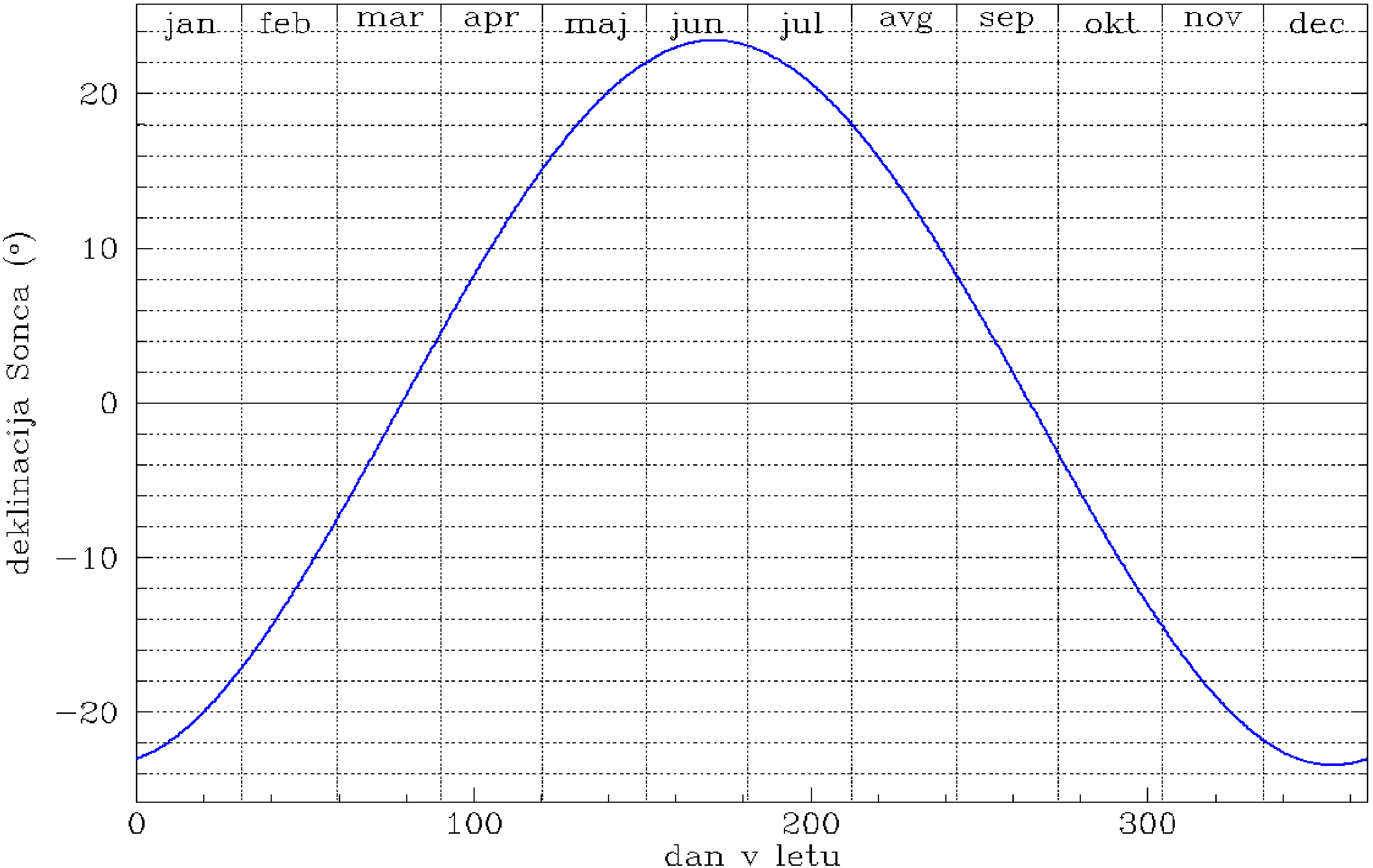
Navidezno letno gibanje Sonca



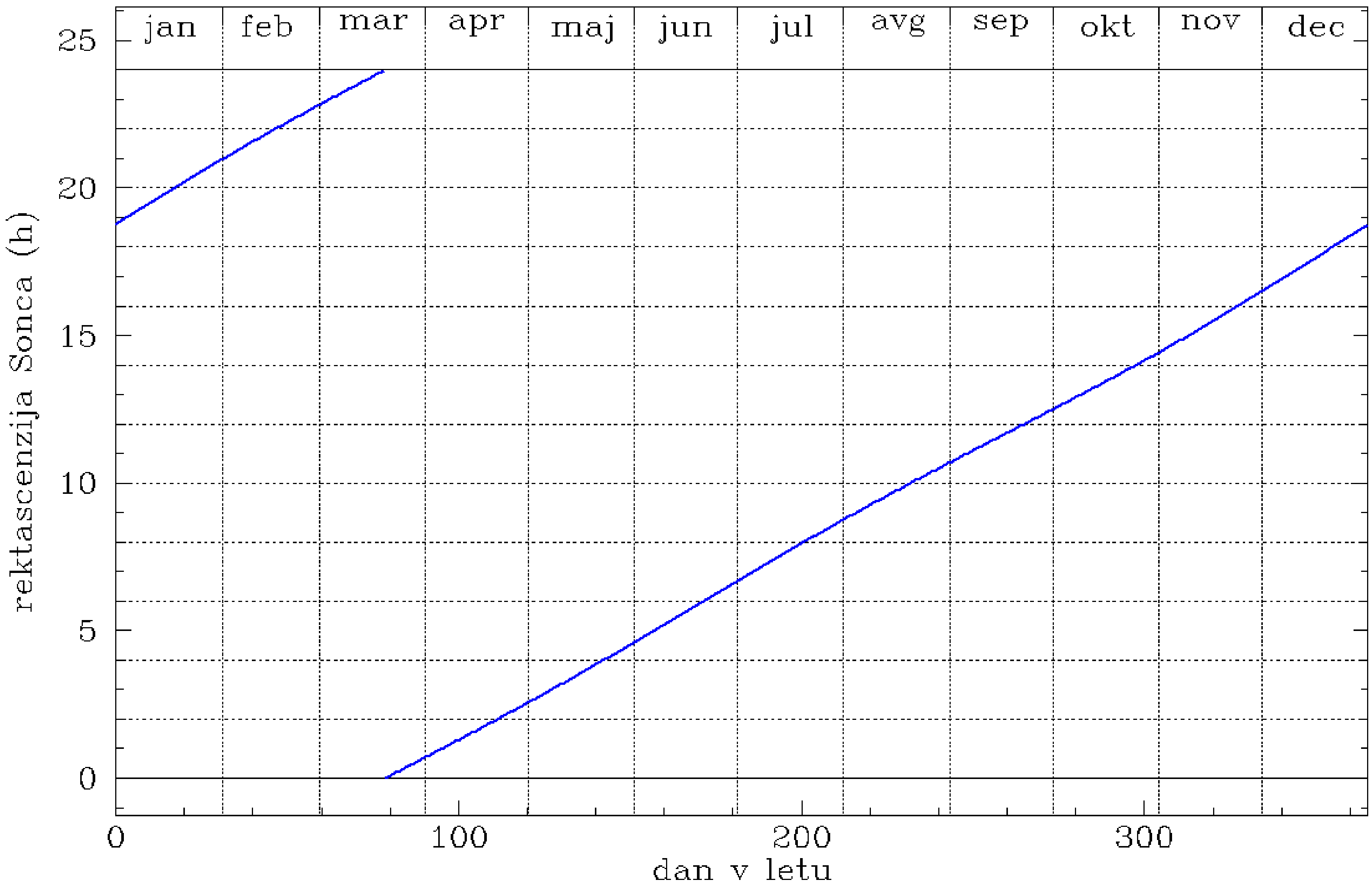
$$\sin\delta = \sin\epsilon \sin L$$

$$\tan\alpha = \cos\epsilon \tan L$$

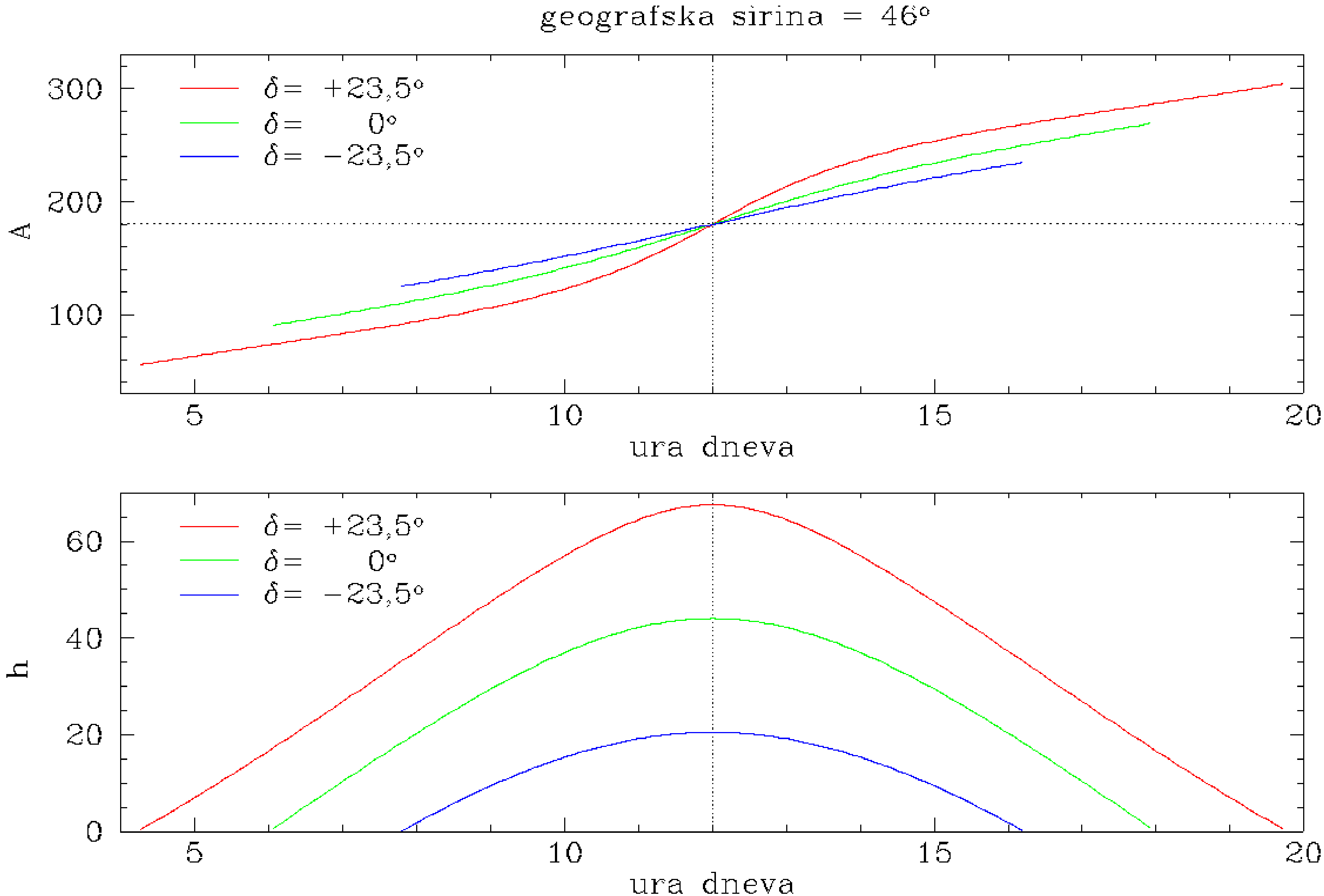
Deklinacija Sonca



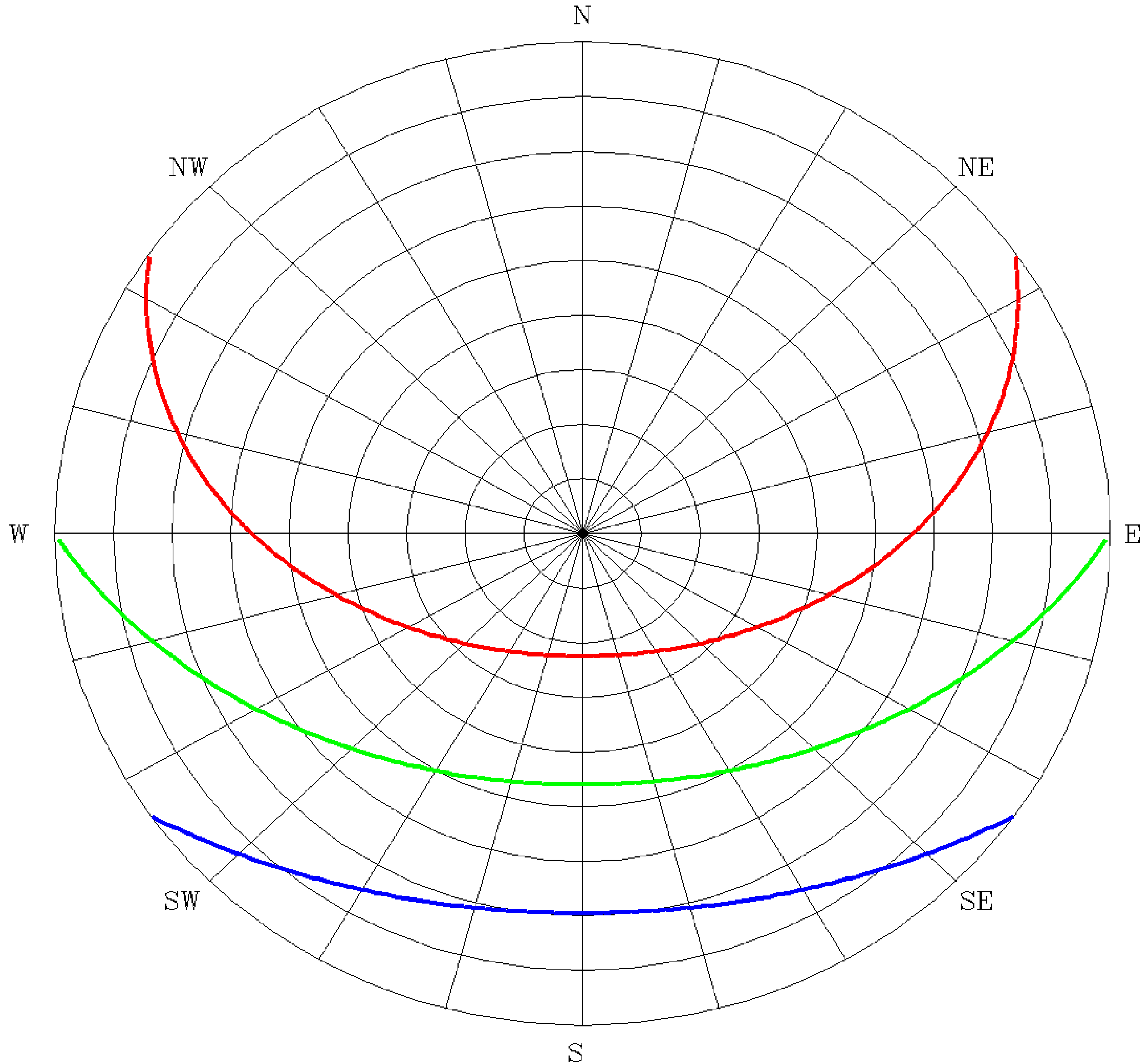
Rektascenzija Sonca



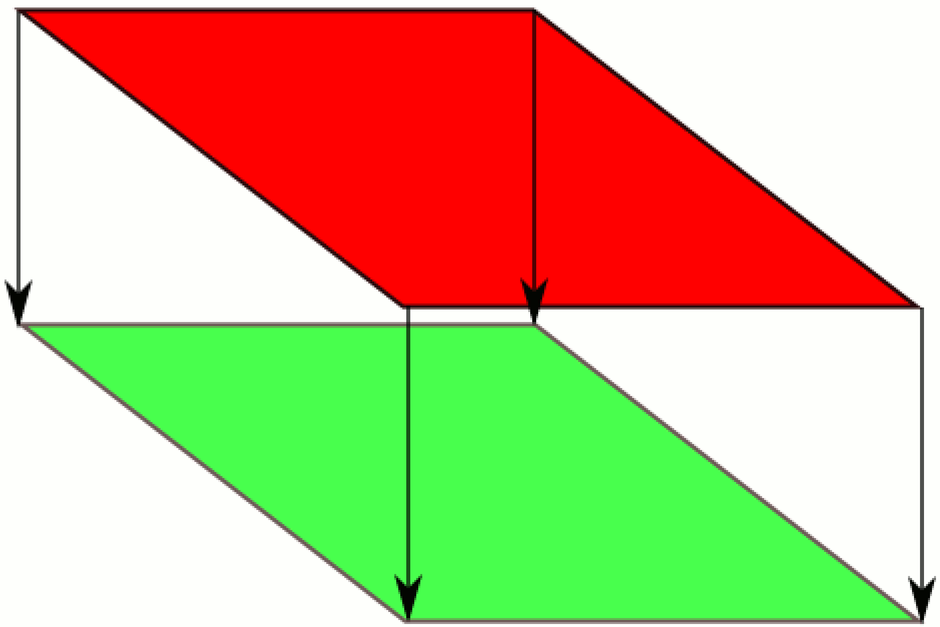
Azimut in višina Sonca

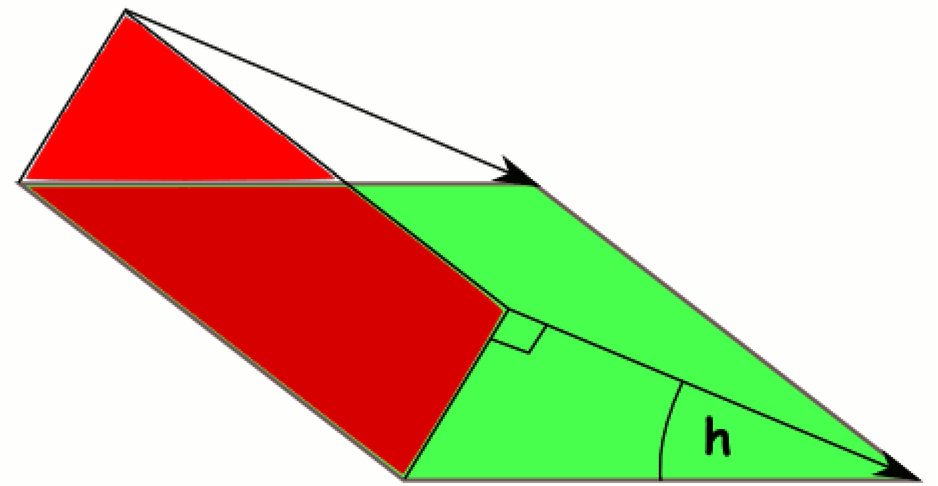


Azimut in višina Sonca

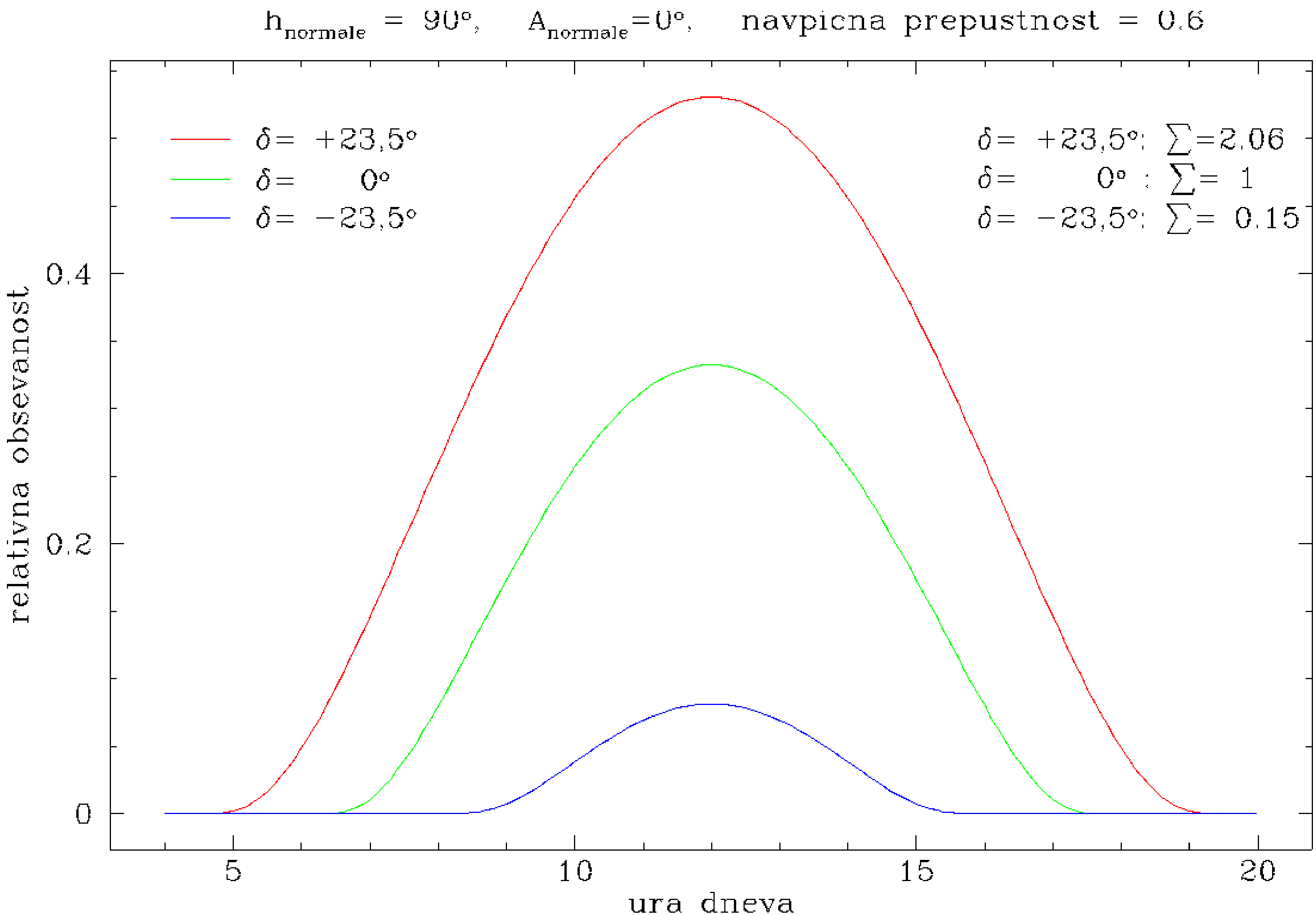


Pravokotno in poševno osvetljena ploskev

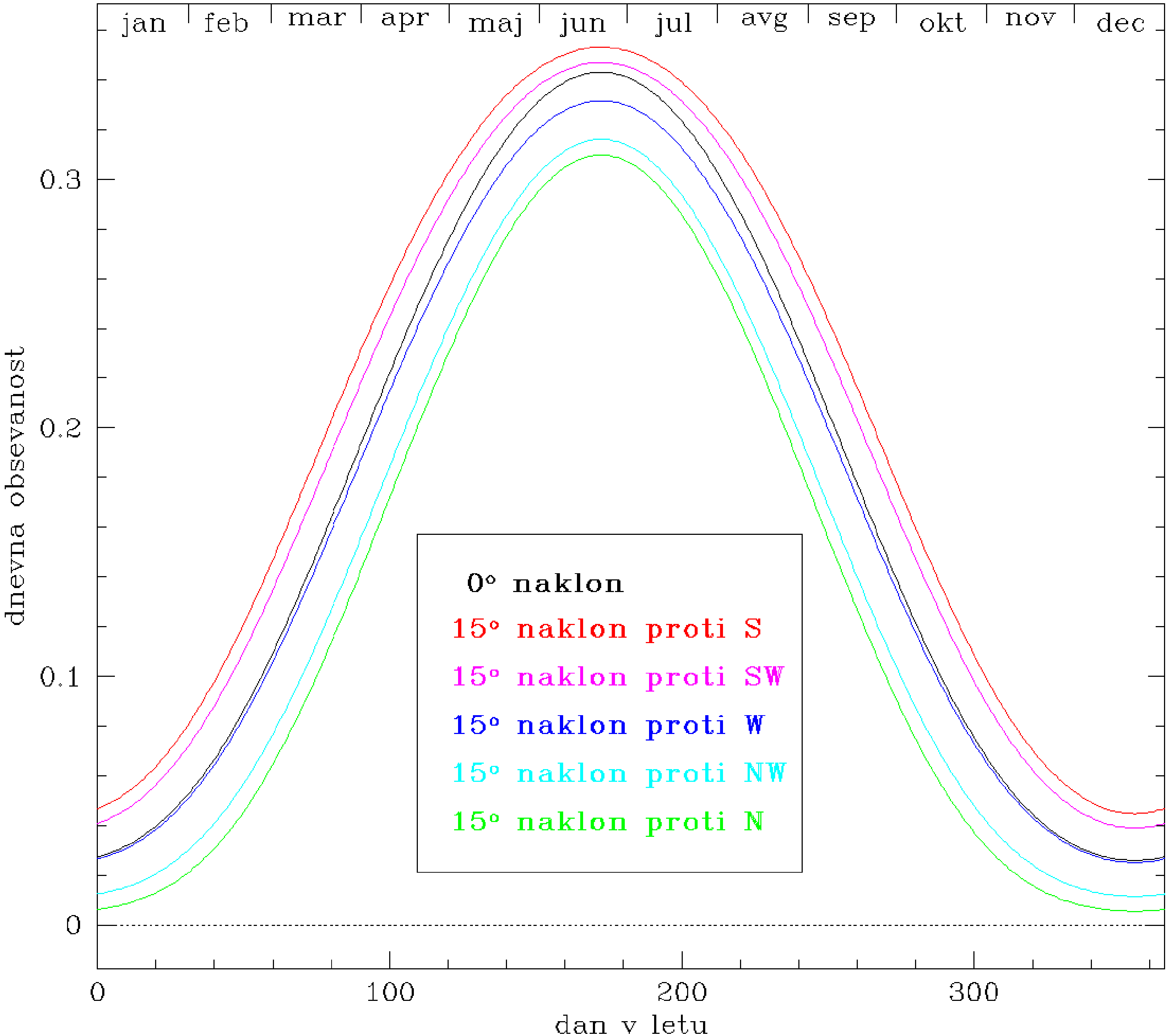




Direktna osvetljenost



Direktna obsevanost skozi leto



Računalniški planetariji

Na trgu zelo veliko programov,

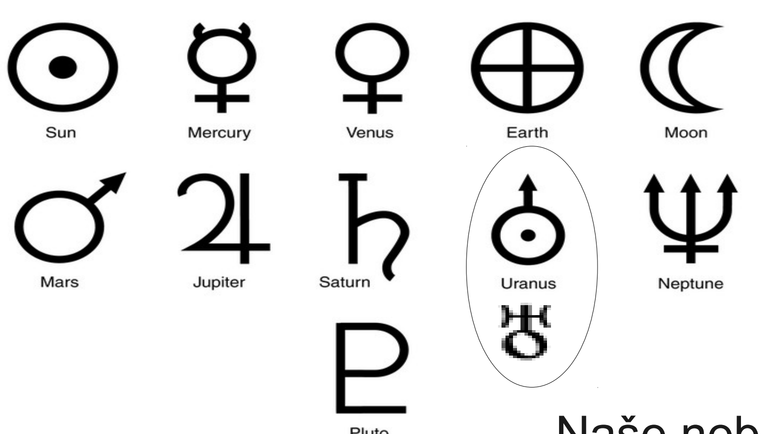
sam bom uporabljal stellarium (http://stellarium.org/),
ki je brezplačen in teče na vseh operacijskih sistemih
(Windows, Linux, Mac).

Trajanje zore in mraka

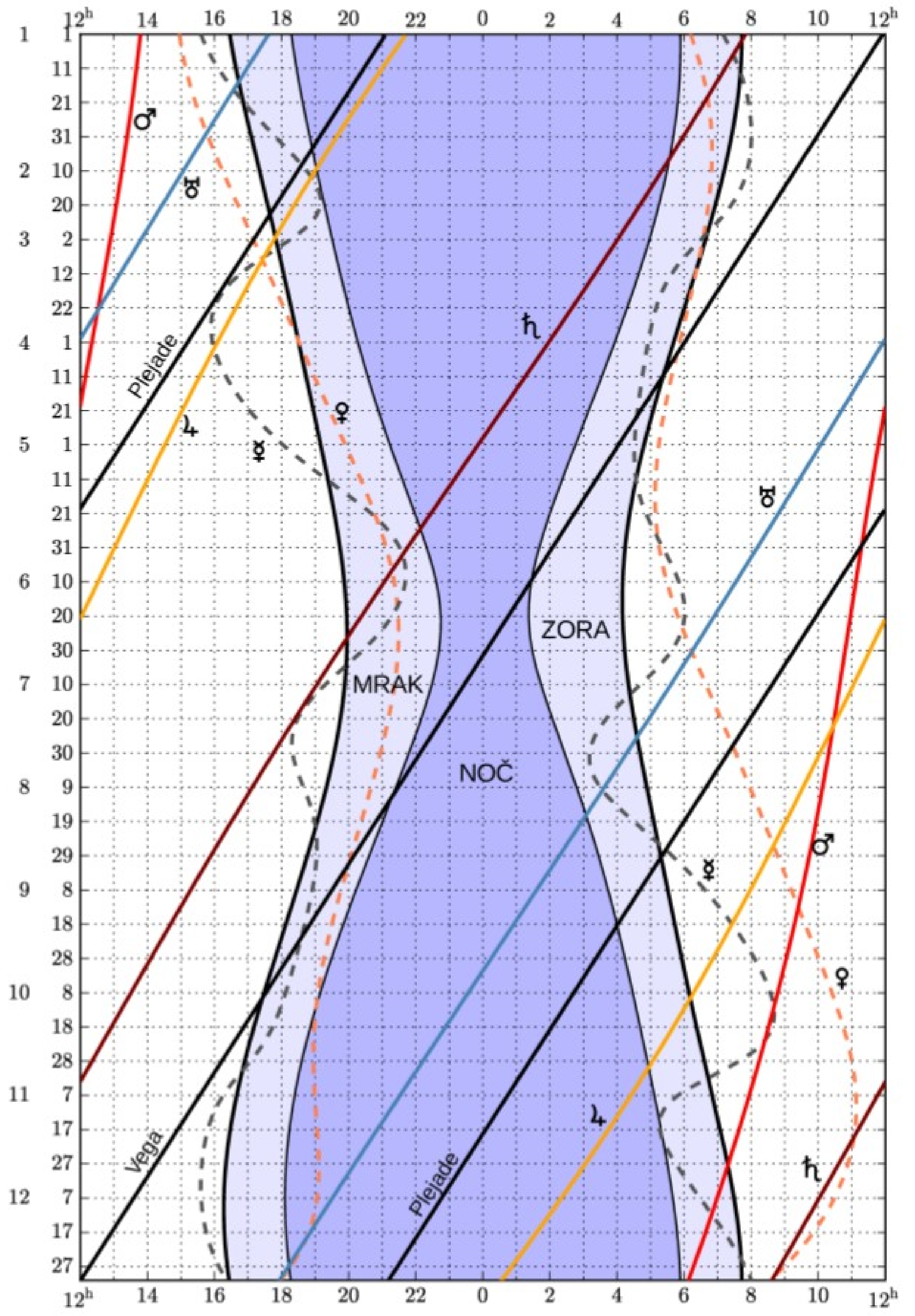
Meščanski: h >= -6°

Navtični: h >= -12°

Astronomski: h >= -18°



Naše nebo, 2013



Popravki k orientaciji po nebu

Lom svetlobe

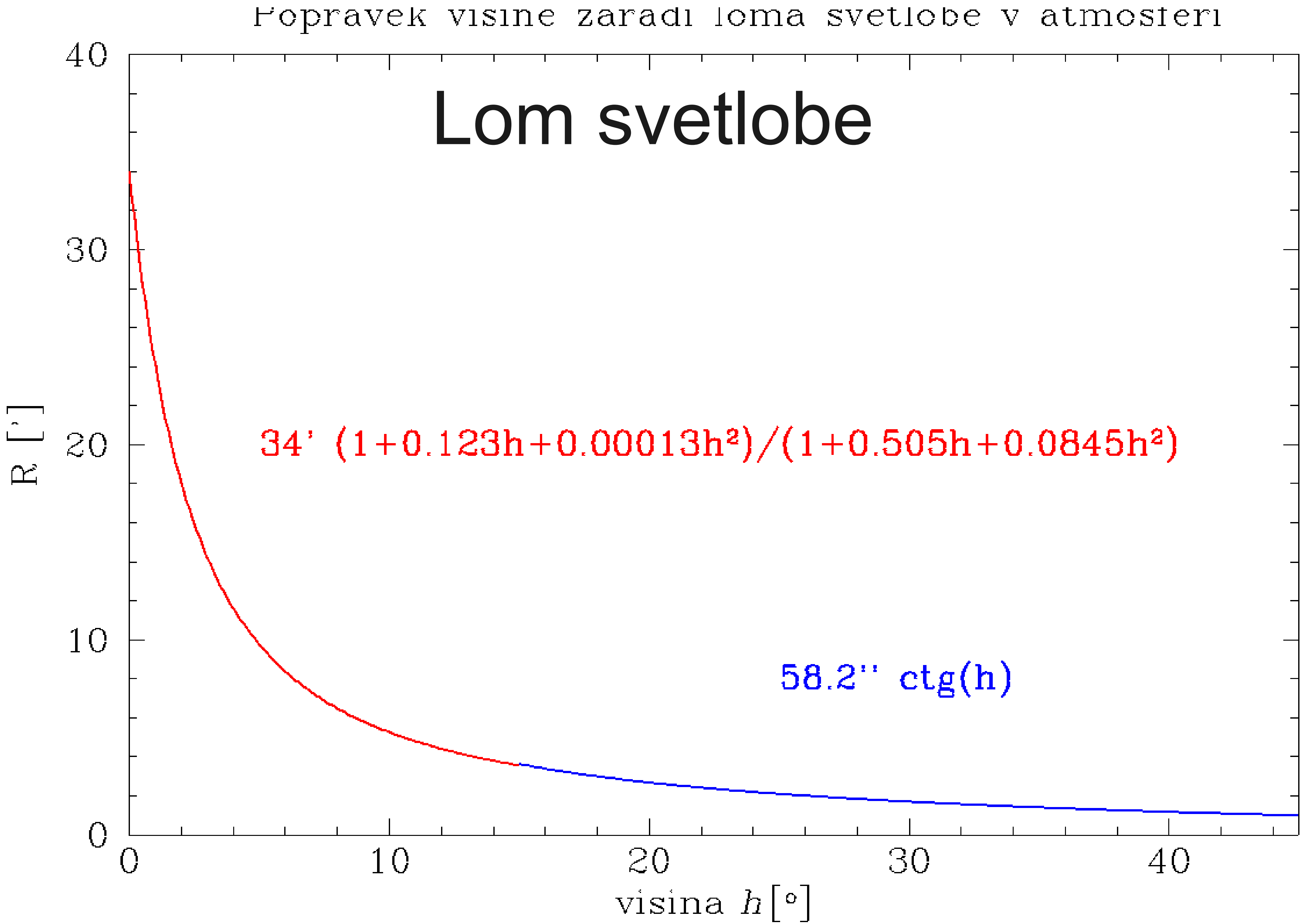
Aberacija svetlobe (amplituda do 20,5")

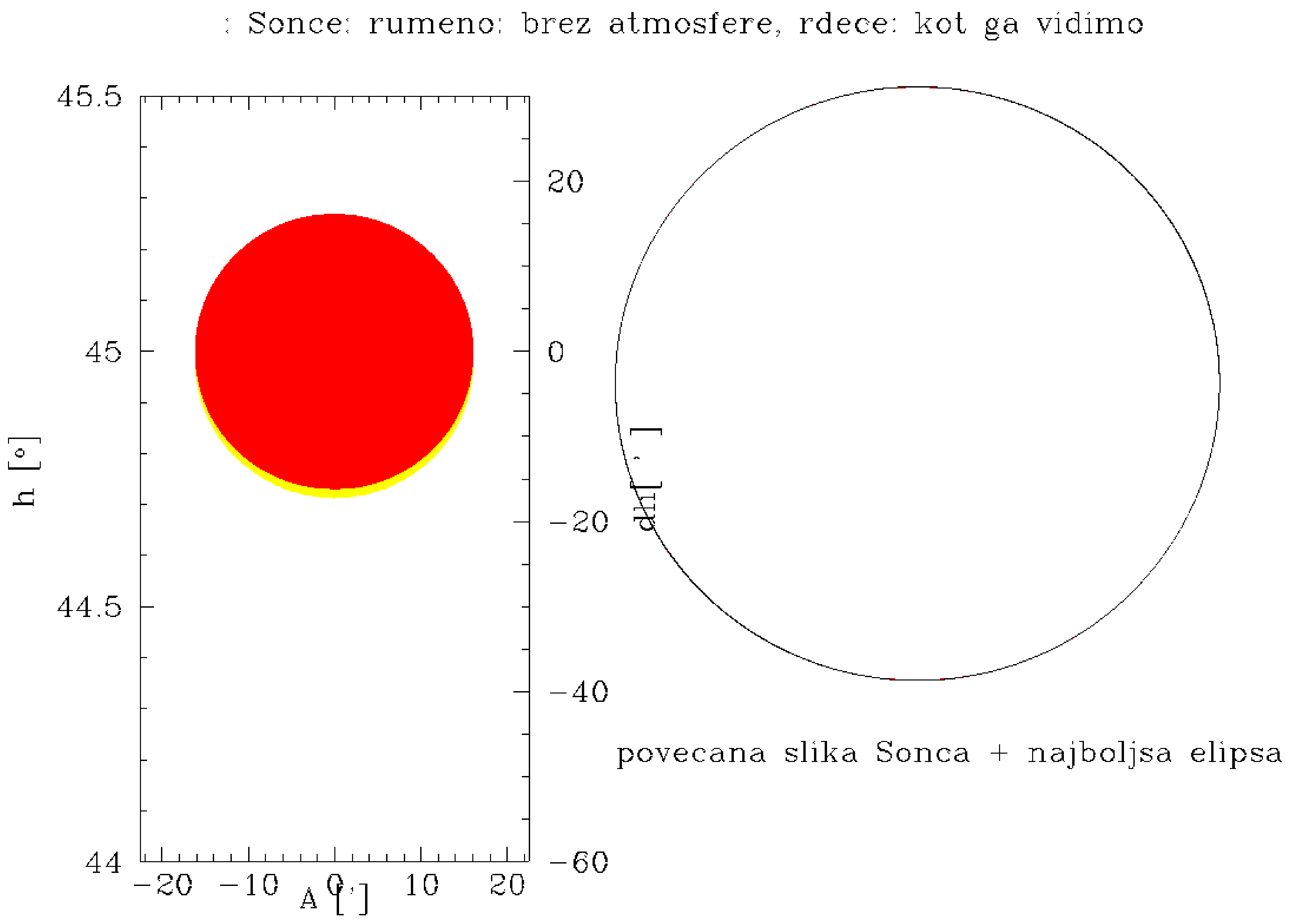
Precesija Zemljine osi (25.800 let,
enakonočje precedira vzdolž ekliptike proti zahodu)

Lastno gibanje

Trigonometrična paralaksa

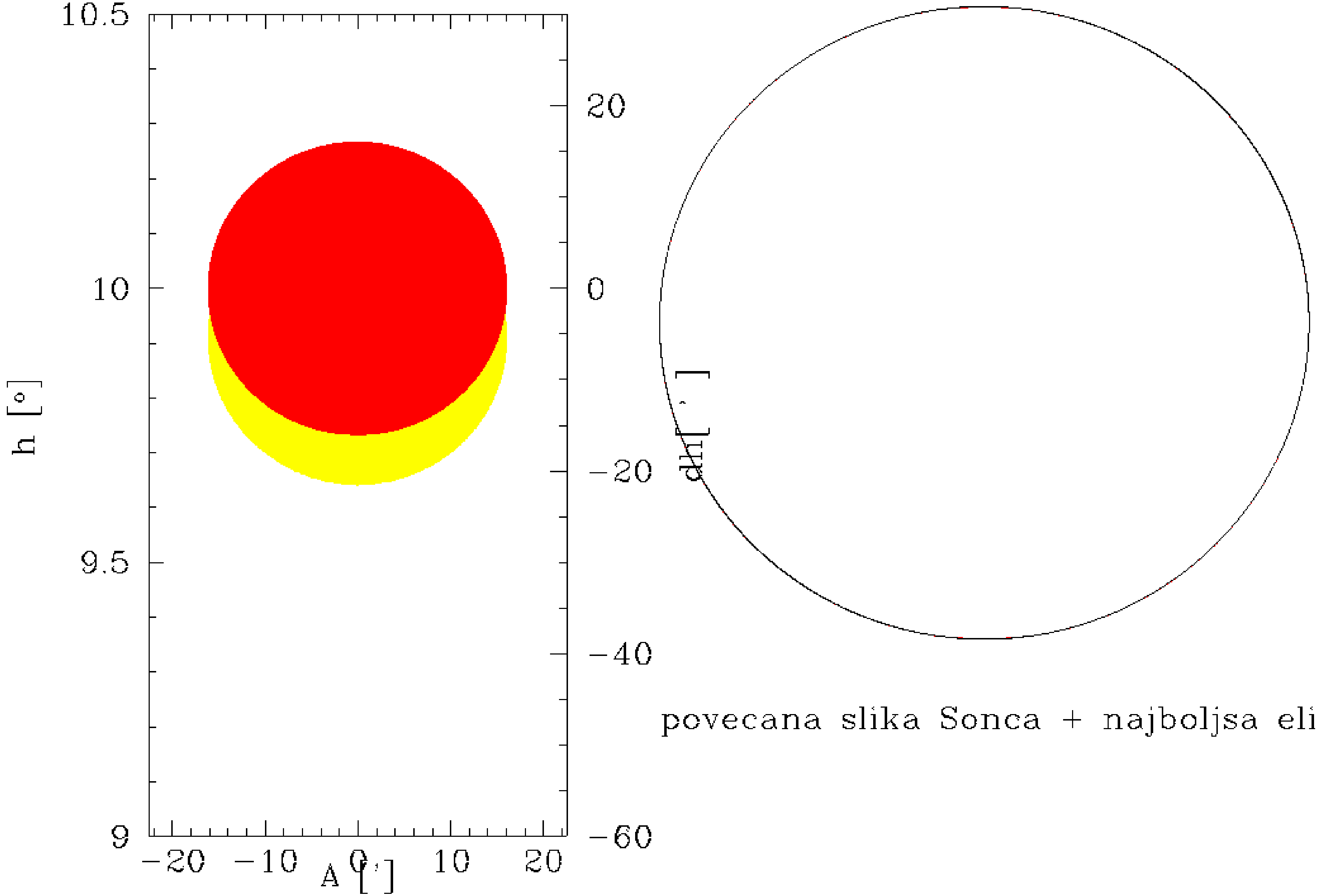
Lom svetlobe





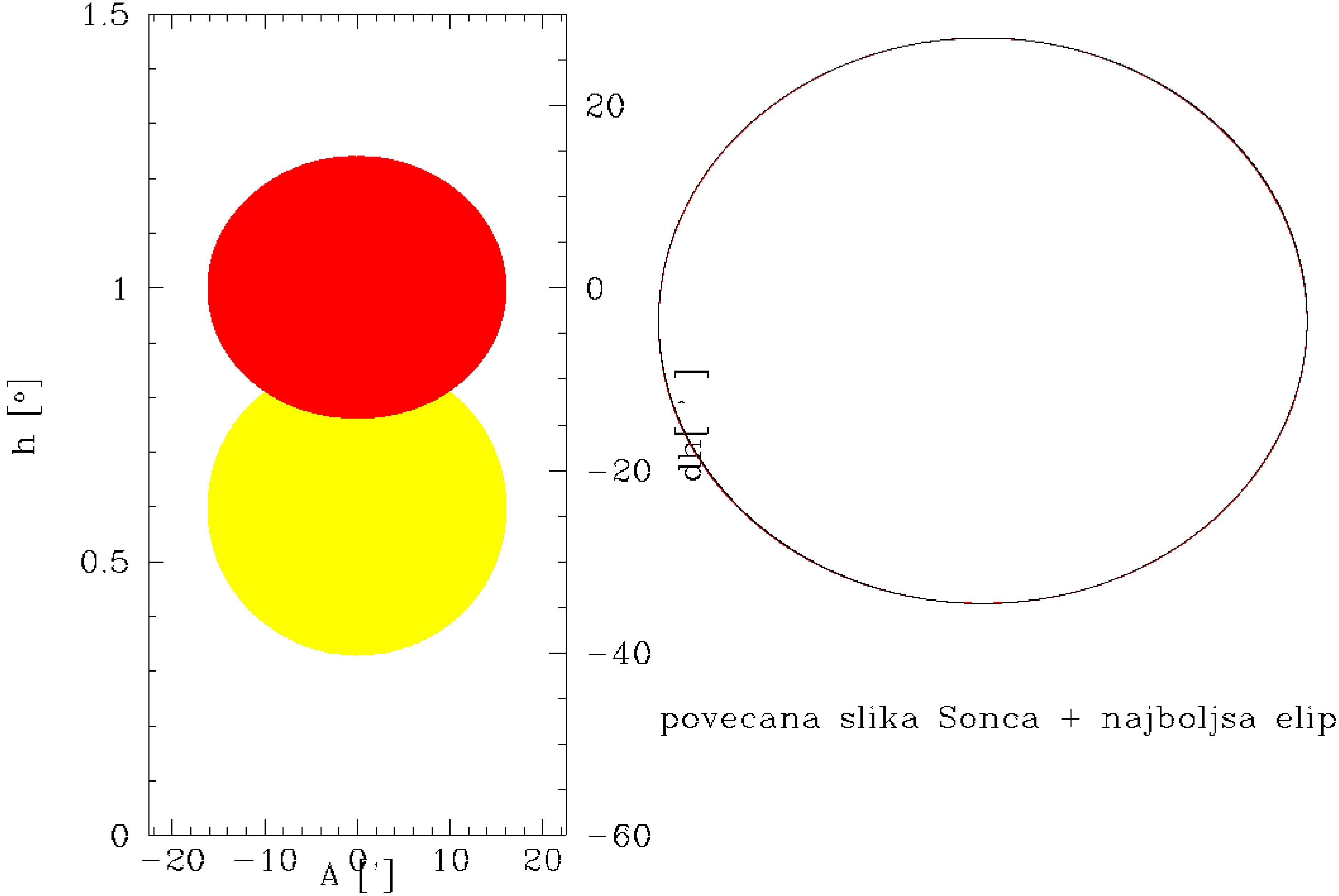
: Sonce: rumeno: brez atmosfere, rdece: kot ga vidimo
45.5
45
44.5
44
h [°]
−20
−10
0
10
20
A [']
20
0
−20
−40
−60
dh [']
povecana slika Sonca + najboljsa elipsa

: Sonce: rumeno: brez atmosfere, rdece: kot ga vidimo

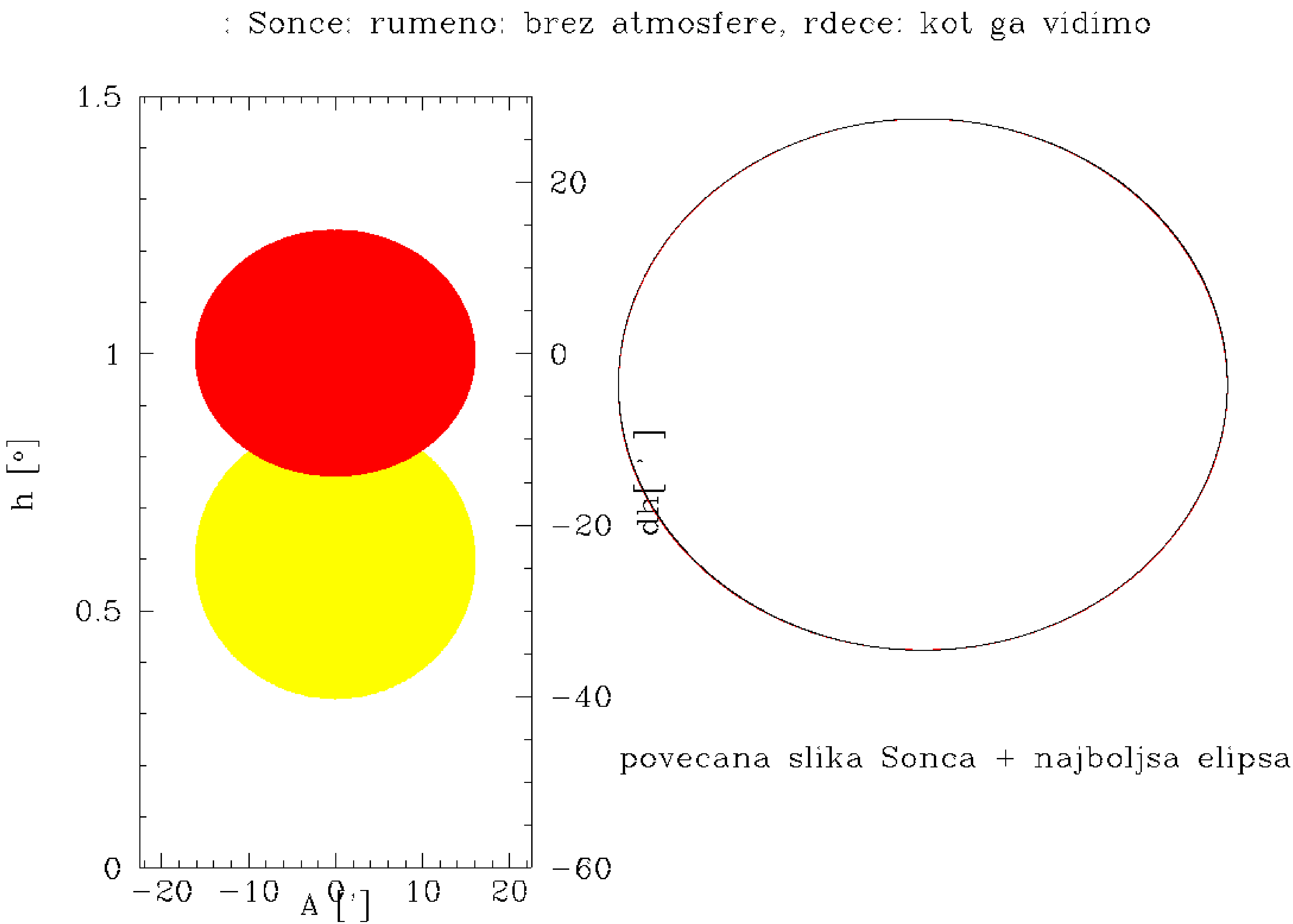


povecana slika Sonca + najboljsa elipsa

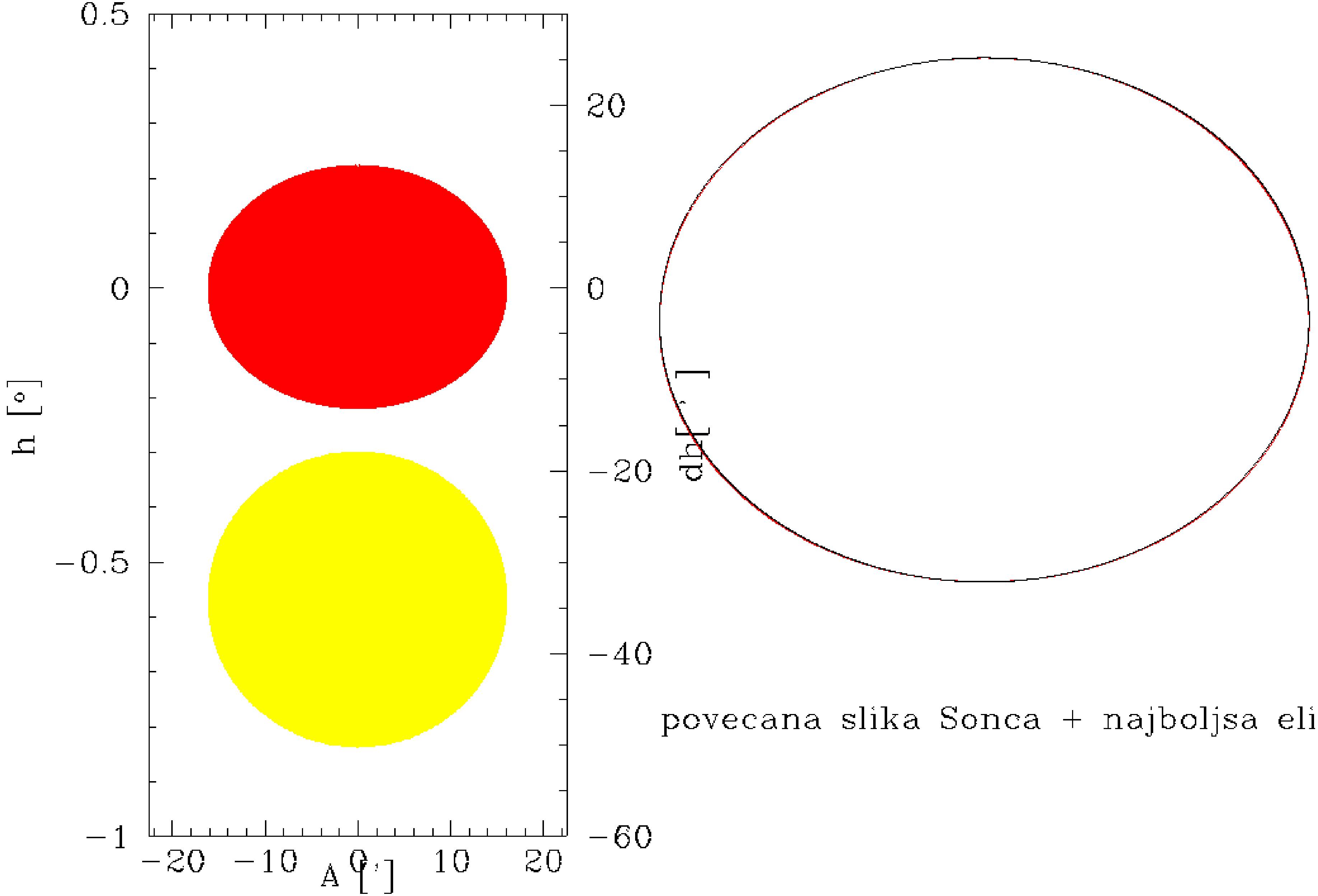
: Sonce: rumeno: brez atmosfere, rdece: kot ga vidimo



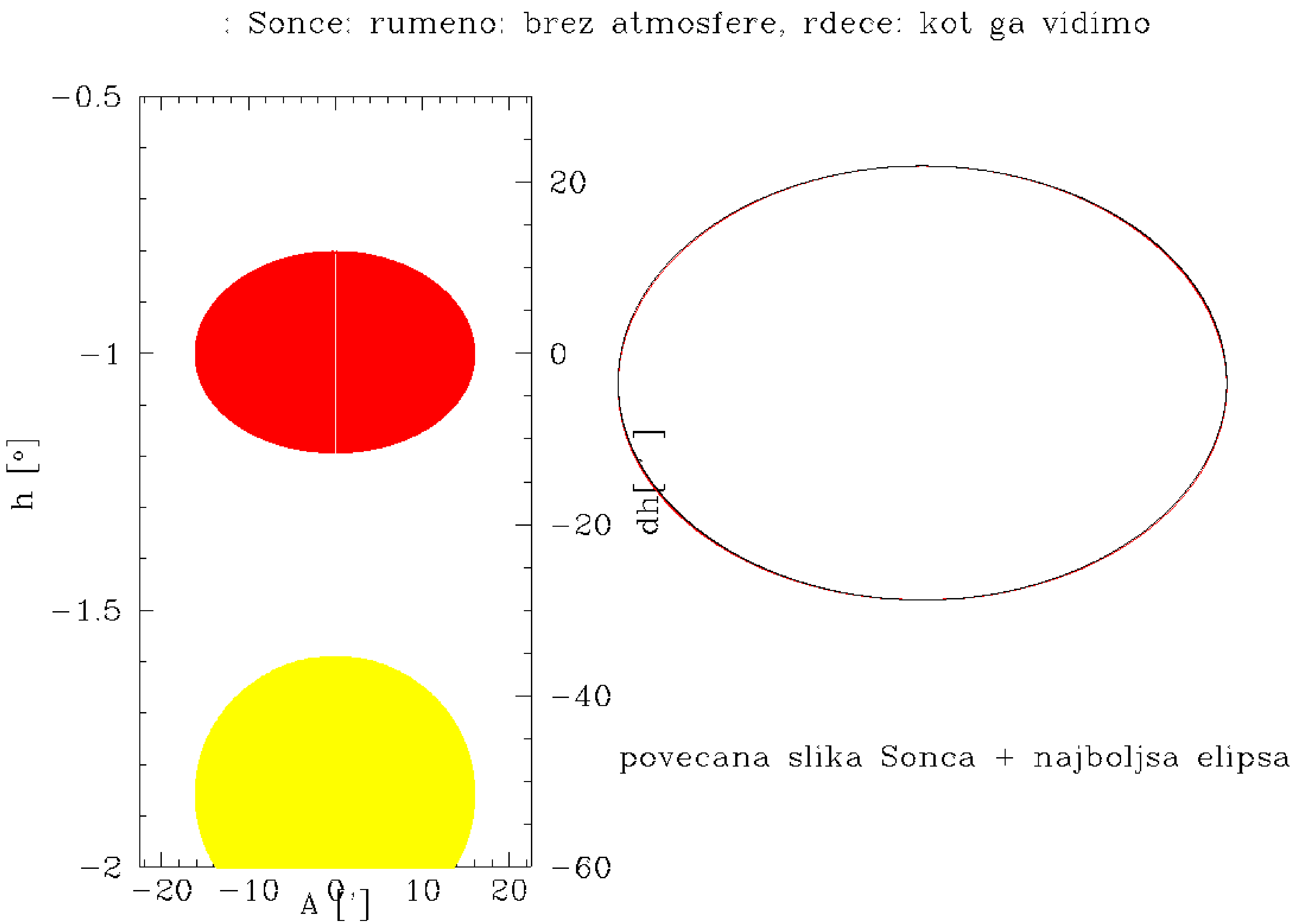
povecana slika Sonca + najboljsa elipsa


: Sonce: rumeno: brez atmosfere, rdece: kot ga vidimo
h [°]
1.5
1
0.5
0
−20
−10
0
10
20
A [']
20
0
−20
−40
−60
dh [']
povecana slika Sonca + najboljsa elipsa

: Sonce: rumeno: brez atmosfere, rdece: kot ga vidimo



povecana slika Sonca + najboljsa elipsa



: Sonce: rumeno: brez atmosfere, rdece: kot ga vidimo
h [°]
A [']
dh[']
−0.5
−1
−1.5
−2
−20
−10
0
10
20
20
0
−20
−40
−60
povecana slika Sonca + najboljsa elipsa

Popravki k orientaciji po nebu

Lom svetlobe

Aberacija svetlobe (amplituda do 20,5")

**Precesija Zemljine osi (25.800 let,
enakonočje precedira vzdolž ekliptike proti zahodu)**

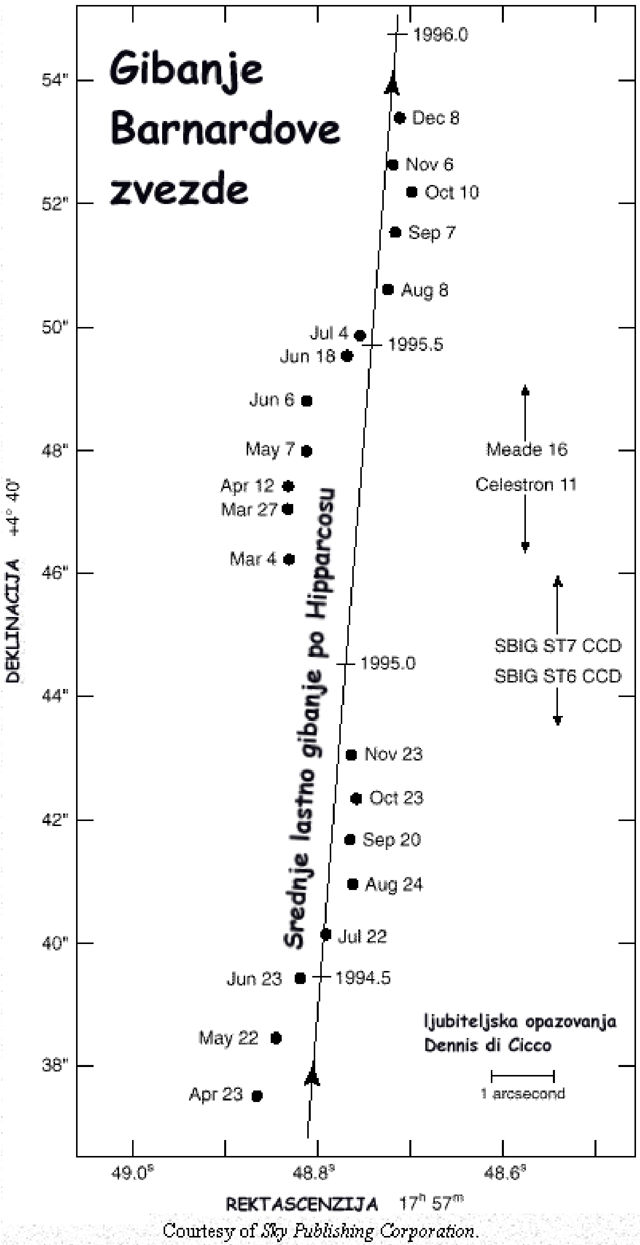
Lastno gibanje

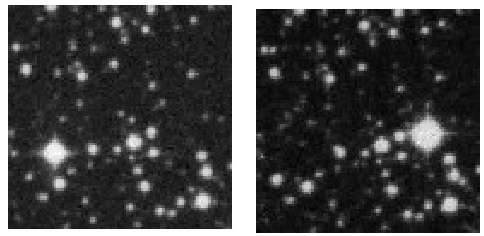
Trigonometrična paralaksa

Različne dolžine leta

Tropsko leto: od enakonočja do enakonočja, doba ponavljanja letnih časov, 365,24219 dni. Približek zanj je povprečna dolžina koledarskega leta: 365,2425 dni.
Zvezdno leto: čas za en obhod Zemlje okoli Sonca. To bi morali vstaviti v Keplerjev zakon. Ker se enakonočje zaradi precesije Zemljine osi pomika proti zahodu, je tropsko leto krajše od zvezdnega. Dolžina zvezdnega: 365,25636 dni.
Anomalistično leto: od perihelija do perihelija Zemlje. Ker se eliptična tirnica Zemlje zaradi vplivov drugih planetov itd. počasi suka, je anomalistično leto vedno 20 minut daljše od zvezdnega. Dolžina anomalističnega leta je 365,25964 dni.

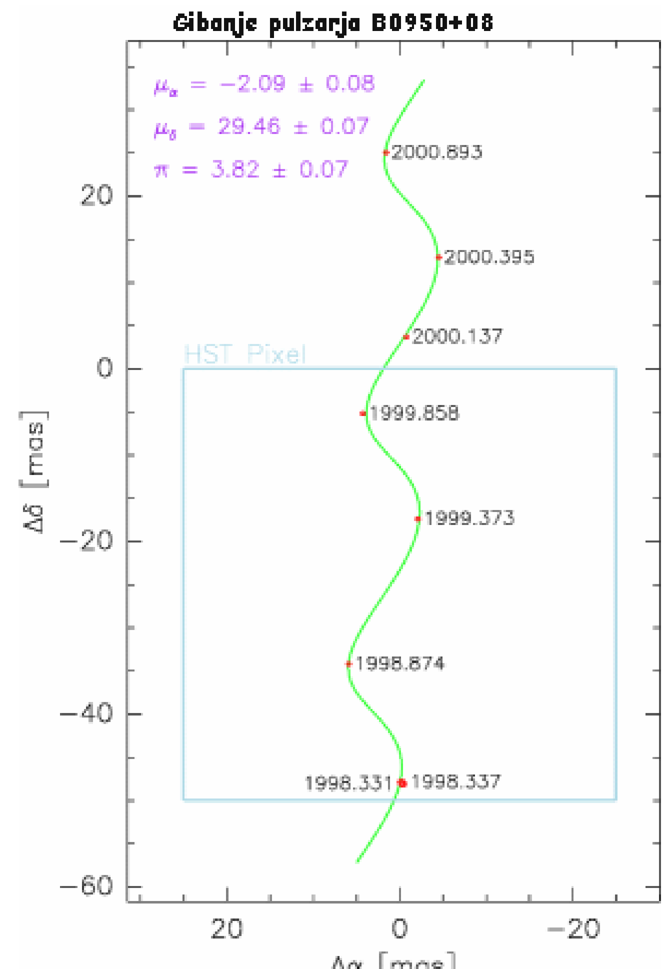
Paralaksa in lastno gibanje



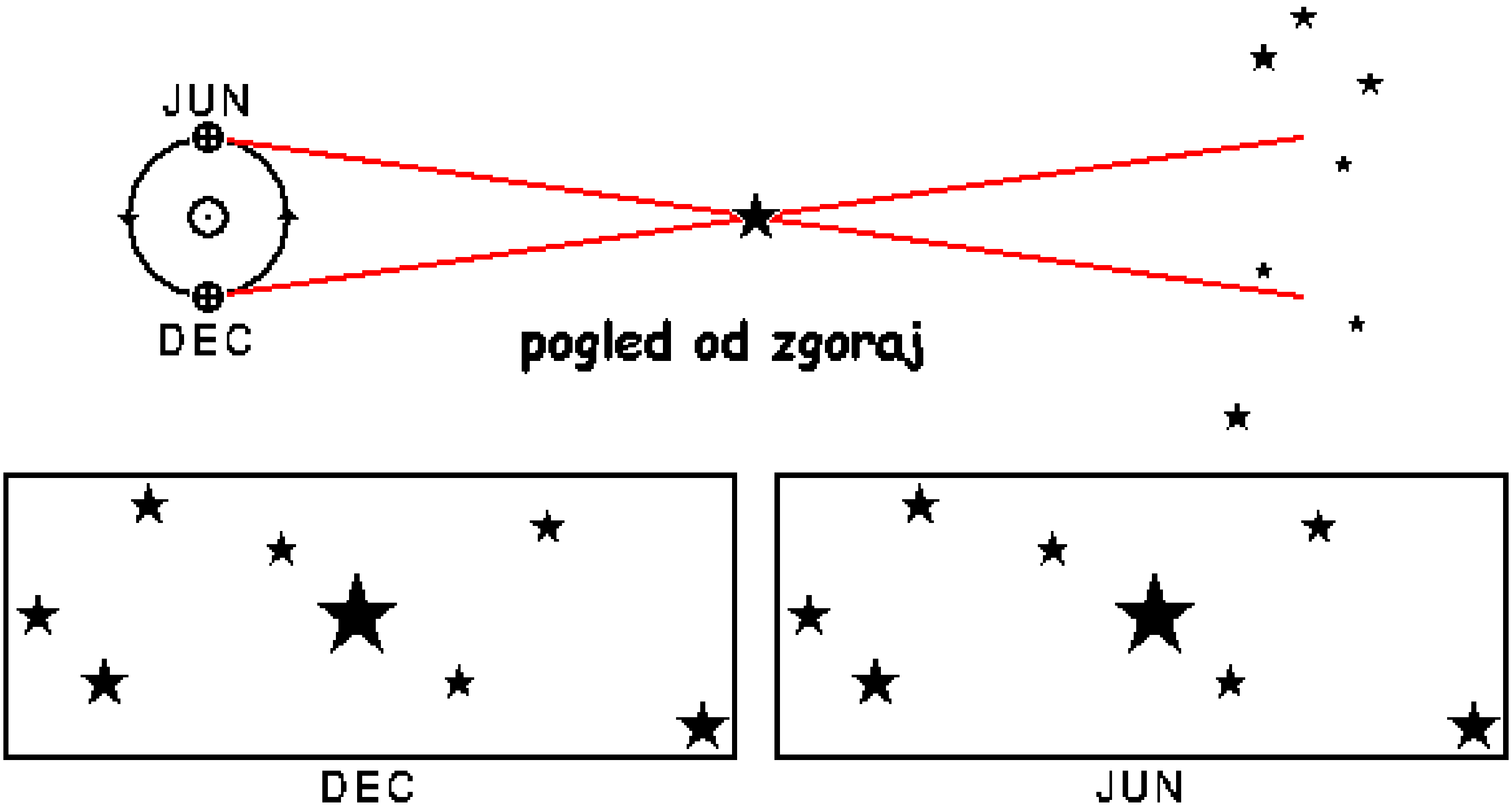


Lastno gibanje Proksime Kentavra med letoma 1976 (levo) in 1993 (desno).

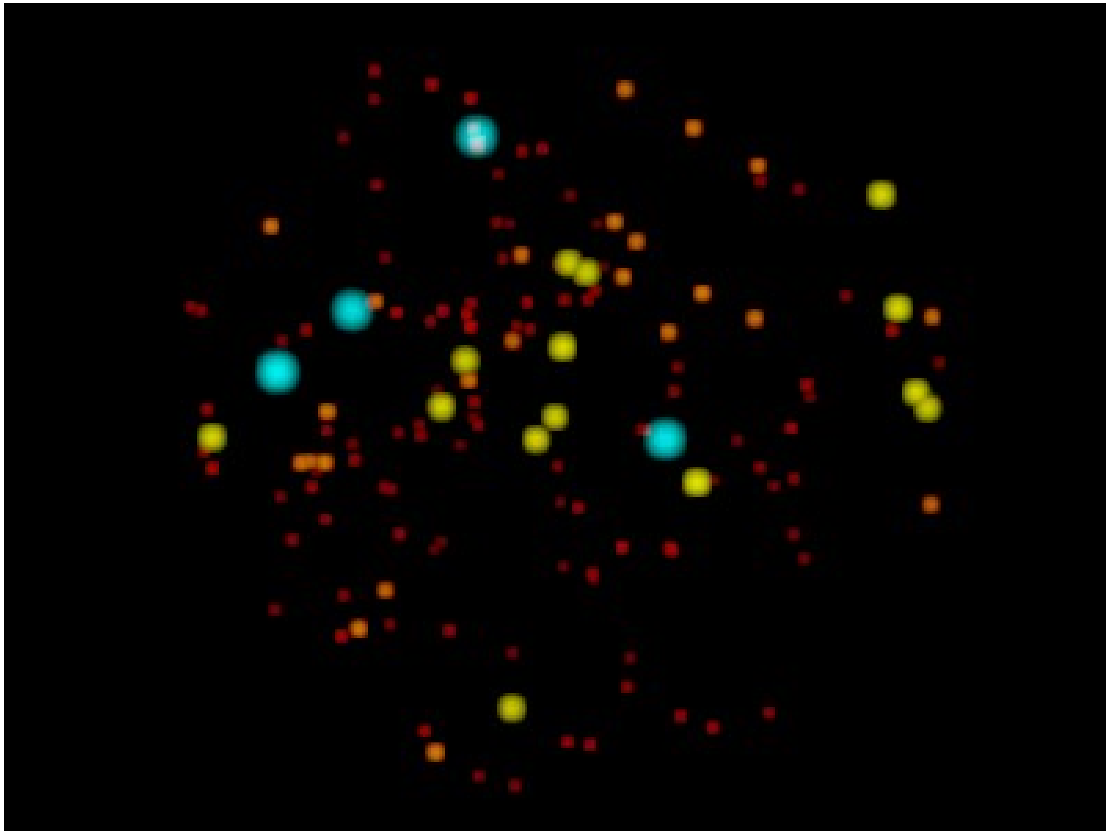
Gibanje Barnardove zvezde v vidni svetlobi (levo) in pulzarja B0950+08 v radijski svetlobi (desno).



Trigonometrična paralaksa



Oddaljenost s paralakso: satelit Hipparcos Evropske vesoljske agencije



Položaj 150 najbljižjih zvezd (d<9 pc) po meritvah satelita Hipparcos.
Barva označuje izsev zvezde:
●: L > 10 L_{Sonce}, ●: 1-10 L_{Sonce}, ●: 0.1-10 L_{Sonce}, ●: <0.1 L_{Sonce}

Simbad, Skyview, …

Simbad VizieR Aladin Catalogs Diction

SIMBAD query result

other query modes : Identifier query | Coordinate query | Criteria query | Reference query | Basic query | Script submission | Output options | Help

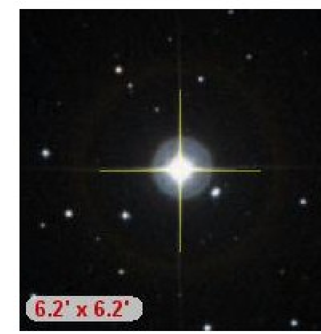
Object query : HD 100 C.D.S. - SIMBAD4 rel 1.193 - 2012.04.02CEST14:01:15

Available data : Basic data • Identifiers • Plot & images • Bibliography • Measurements • External archives • Notes • Annotations

Basic data :

HD 100 -- Star query around with radius 2 arcmin

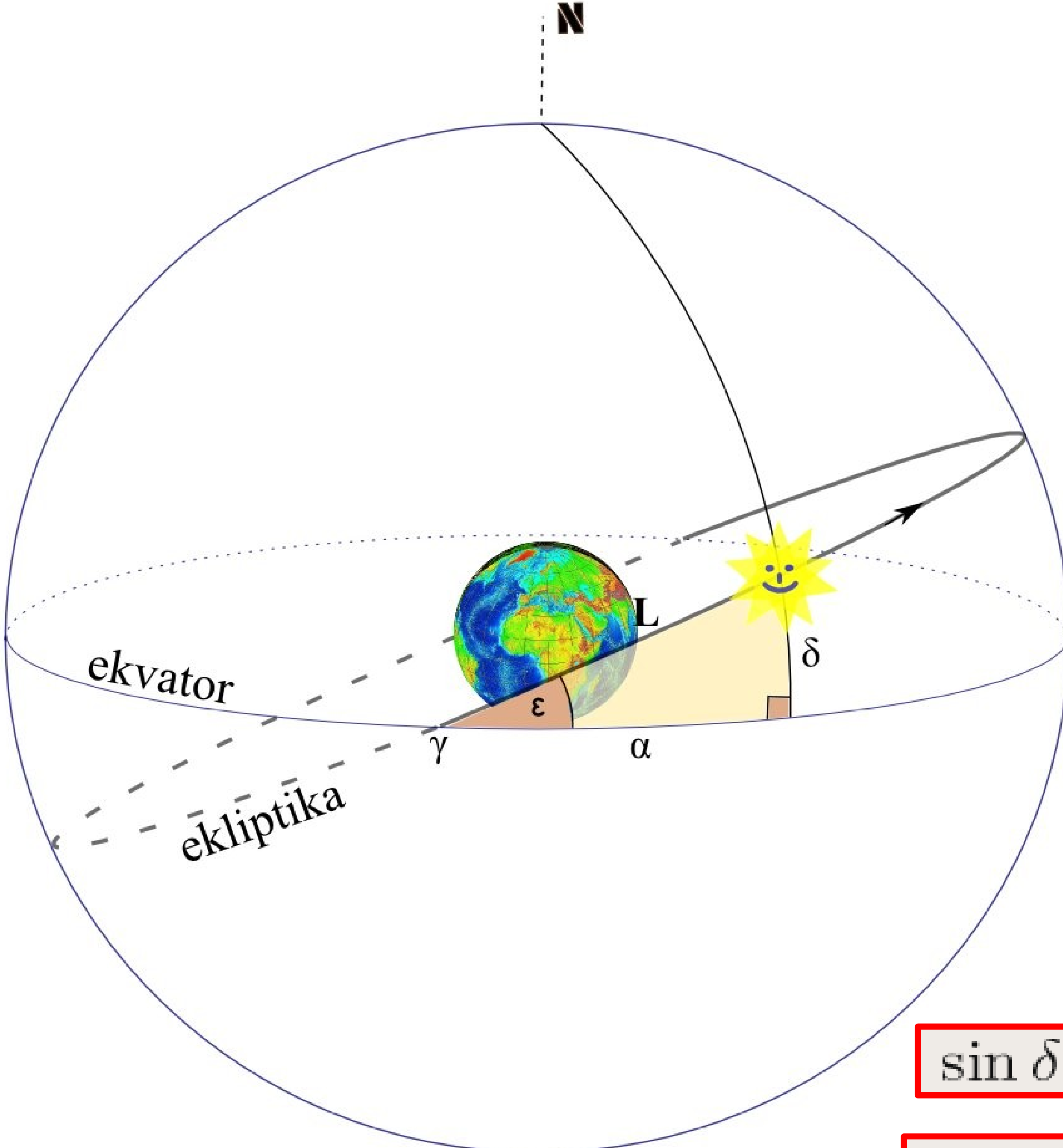
Other object types:	* (HD, AG, AGKR, BD, DO, GC, GSC, HIC, HIP, PPM, SAO, SKY#, TYC, YZ) , IR (IRAS, IRC, 2MASS)
ICRS coord. (ep=J2000) :	00 05 56.73130 +24 34 08.4122 (Optical) [3.43 2.29 0] A 2007A&A...474..653V
FK5 coord. (ep=J2000 eq=2000) :	00 05 56.731 +24 34 08.41 (Optical) [3.43 2.29 0] A 2007A&A...474..653V
FK4 coord. (ep=B1950 eq=1950) :	00 03 22.22 +24 17 27.3 (Optical) [19.80 13.20 0] A 2007A&A...474..653V
Gal coord. (ep=J2000) :	109.9284 -37.1514 (Optical) [3.43 2.29 0] A 2007A&A...474..653V
Proper motions *mas/yr* [error ellipse]:	34.79 -17.54 [0.39 0.26 0] A 2007A&A...474..653V
Radial velocity / Redshift / cz :	V(km/s) -14.36 [0.22] / z(~) -0.000048 [0.000001] / cz -14.36 [0.22] (~) B 2005A&A...430..165F
Parallaxes *mas*:	3.48 [0.42] A 2007A&A...474..653V
Spectral type:	K5 D ~
Fluxes (5) :	B 8.502 [~] D ~ V 6.902 [~] D ~ J 4.297 [0.280] C 2003yCat.2246....0C H 3.469 [0.236] C 2003yCat.2246....0C K 3.182 [0.346] C 2003yCat.2246....0C



Identifiers (17) :

HD 100	GC 83	IRC +20001	TYC 1729-631-1
AG+24 6	GSC 01729-00631	2MASS J00055672+2434084	YZ 24 9205
AGKR 51	HIC 496	PPM 89402	
BD+23 4853	HIP 496	SAO 73737	
DO 8162	IRAS 00033+2417	SKY# 176	

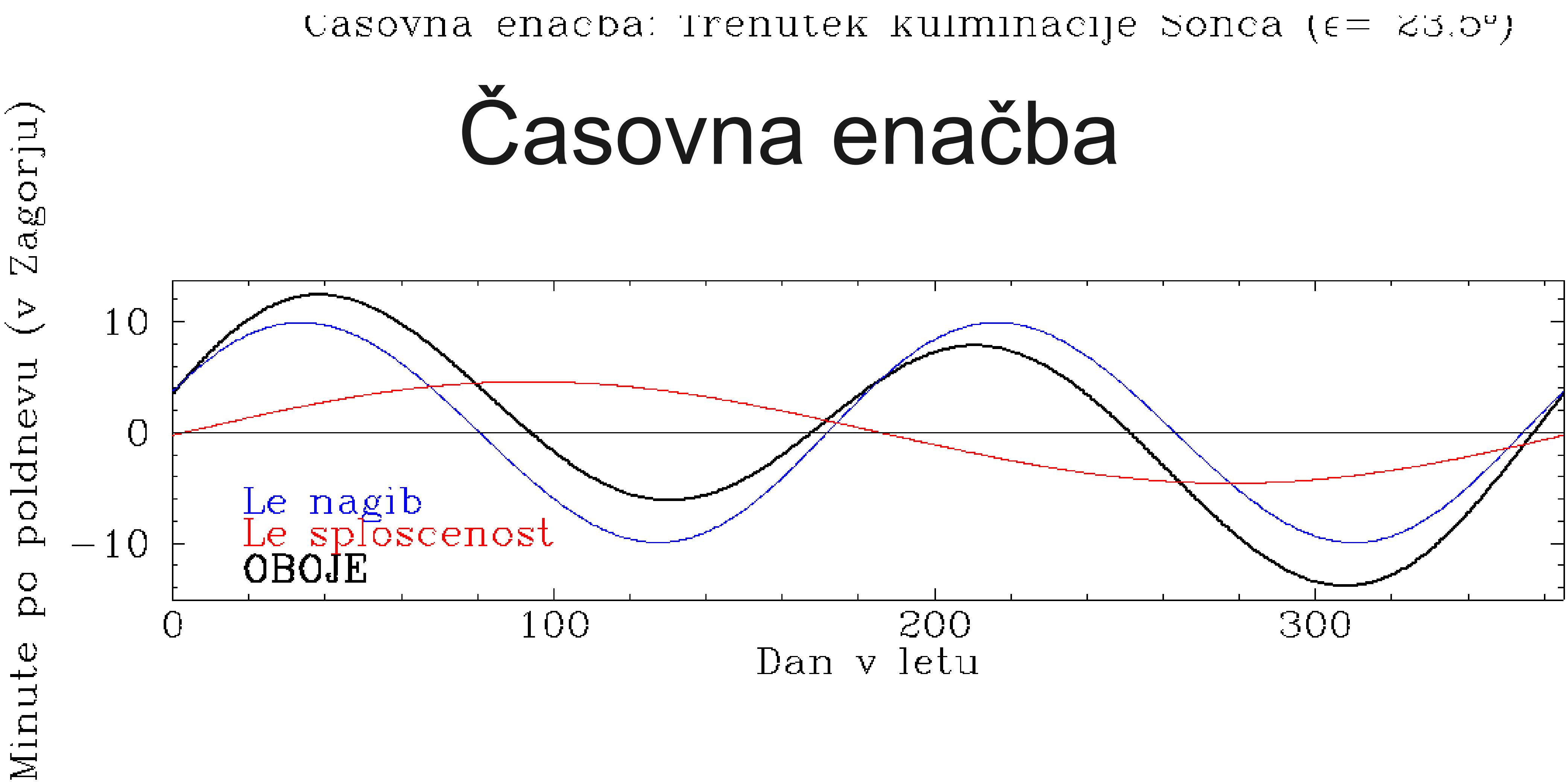
Navidezno letno gibanje Sonca

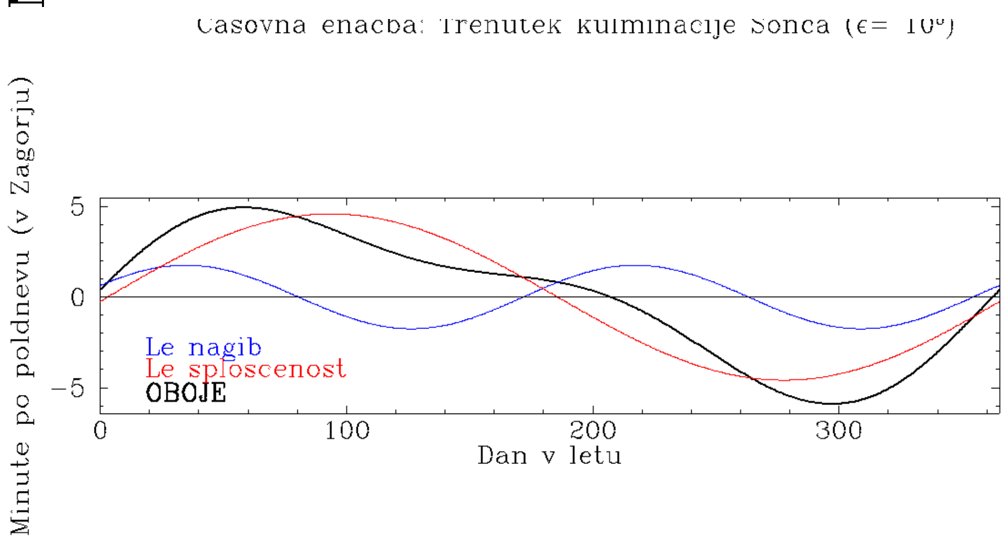


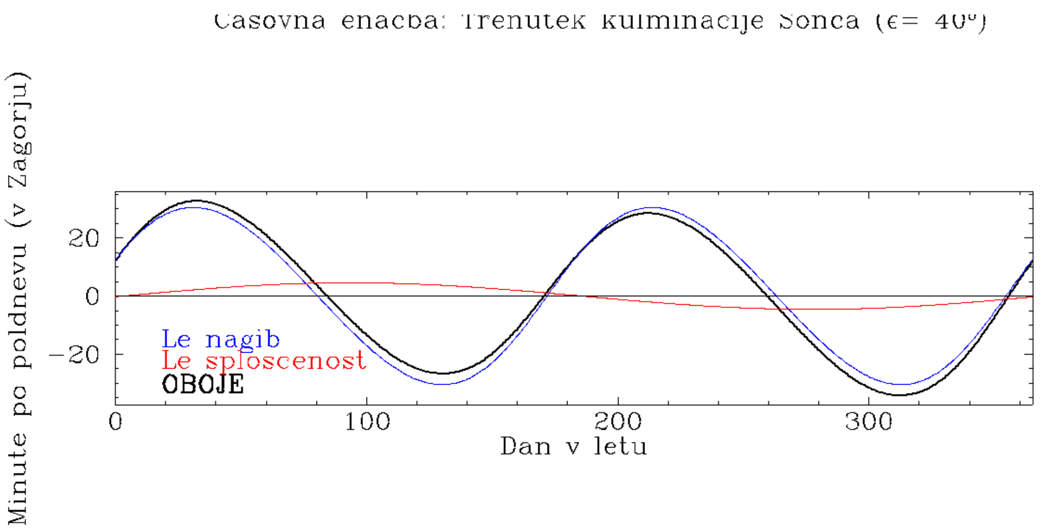
$$\sin\delta = \sin\epsilon \sin L$$

$$\tan\alpha = \cos\epsilon \tan L$$

Časovna enačba







Čas in njegove definicije

- Čas UT0: lega Sonca popravljena za časovno enačbo, to je srednji Sončev čas.

- Čas UT1: upošteva še premik lege Zemljinega pola, t.j. ura, ki ima za enoto vrtljaj Zemlje glede na oddaljene zvezde.

- Čas UT2: upošteva še manjše popravke v Zemljini skorji, denimo taljenje ledu. Popravki onkraj UT2 so naključni, torej nepredvidljivi. Napaka pribl. 60 ms/leto.

- Današnja skala UTC ima pribl. milijonkrat manjšo napako, a zanjo potrebujemo novo definicijo.

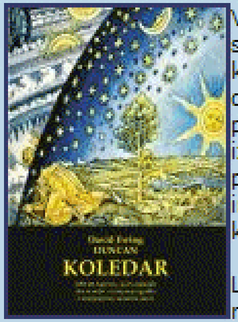
Čas v astronomiji

KVARKADABRA

časopis za tolmačenje znanosti

O Kvarkadabri | knjige | predavanja | aktivnosti | povezave | zani

David Ewing Duncan: Koledar



Več tisočletij so bile tri naravne periode (dan, mesec in leto) edine enote, s katerimi so ljudje merili čas. Za čim lažje štetje teh period in reševanje težav, ki se pojavijo, ker se npr. v enem letu ne zvrsti točno 365 dni, ampak še dodatna slaba četrtina dneva, so ljudje iznašli najrazličnejše sisteme »časovnega knjigovodstva«, ki jim pravimo koledarji. David Ewing Duncan pripoveduje v knjigi Koledar zgodovino iskanja in izpopolnjevanja učinkovitih metod štetja časa. Knjiga na izviren in zabaven način povezuje politiko, religijo, astronomijo in matematiko. Skozi zgodbe o vladarjih, papežih, matematikih in menihih Duncan prepričljivo pokaže, da koledar nikakor ni zgolj obrobna kulturna konvencija, ampak eden od temeljnih stebrov vsake civilizacije.

Le najvplivnejši vladarji v zgodovini so si upali posegati v ustaljene metode štetja in razvrščanja dni v letu. Julij Cezar je tako letu 46 pr.n.š. dodal 80 dni, papež Gregor XIII. pa je leto 1582 skrajšal za deset dni. Ko je tudi Kitajska 1. oktobra 1949 sprejela gregorijanski koledar, se je prvič v zgodovini uradno cel svet uskladil glede zapisovanja datumov. Stephen Jay Gould je – kot eden najboljših esejistov s področja zgodovine znanosti – v svoji recenziji Duncanovega Koledarja zapisal: »Knjiga bo bralcem dokazala, da lahko uvrstimo osnovanje konsistentnega in priročnega koledarja med največje dosežke človeštva; koledar je utelešenje naše kulturne zgodovine in njenega napredka.«

Duncanova knjiga Koledar spada v zvrst pregledne strokovne literature, ki je namenjena širokemu krogu bralcev. Zgodovino koledarja obravnava skozi preplet znanosti, religije, filozofije in politike. Napisana je v za bralca zelo prijaznem jeziku. Avtor se trudi strokovne razlage predstaviti v čimbolj preprosti obliki, hkrati pa še vedno ohrani visok strokovni nivo. O kvaliteti knjige priča tudi podatek, da so jo prevedli že v 21 jezikov, v mnogih državah pa je bila tudi velika prodajna uspešnica.

David Duncan je avtor več knjig, esejev, člankov in kratkih zgodb. Je znanstveni dopisnik mnogih revij in časopisov. Na univerzi Stanford predava pisanje o znanosti, hkrati pa je tudi režiser in producent televizijskih dokumentarnih serij na ABC in Discovery.

DUNCAN, David Ewing - Koledar : 5000 let naporov, da bi uskladili uro in nebo; [prevedel in spremno besedo napisal Sašo Dolenc]. - Ljubljana : Studia humanitatis, 2004. - (Zbirka Varia / Studia humanitatis). - ISBN 961-6262-53-X.

Definicija sekunde

- 1 sekunda = 9,192,631,710 nihajev cezijevega atoma 133Cs pri prehodu med hiperfinima nivojema osnovnega stanja preračunano na 0 K.
- Do te številke so prišli, tako da so merili povprečno dolžino sekunde med letoma 1750 in 1890.
- Relativistični popravki: geocentrični sistem z uro, ki bi se nahajala na površini geoida.

Čas UTC (“koordinirani”)

- Želimo okvirno skladnost med časom glede na Sonce in Cezijevo uro. Nerešljiva naloga, ker se Zemlja vrti neenakomerno, atomska ura pa teče enakomerno.

- Kompromis čas UTC, kjer so sekunde po Cezijevi definiciji, za okvirno uskladitev s srednjim Sončevim časom pa uvajajo prestopne sekunde.

- Pravilo: prestopna sekunda uvedena konec kateregakoli meseca (najraj decembra ali junija), če razlika med UTC in UT1 preseže 0,9 sekunde.

INFORMATION ON UTC - TAI

The last additional second was introduced on 1 January 1999, at 0h.

Paris, 4 July 2005

Bulletin C 30

To authorities responsible for the measurement and distribution of time

UTC TIME STEP on the 1st of January 2006

A positive leap second will be introduced at the end of December 2005.
The sequence of dates of the UTC second markers will be:

2005 December 31, 23h 59m 59s
2005 December 31, 23h 59m 60s
2006 January 1, 0h 0m 0s

The difference between UTC and the International Atomic Time TAI is:

from 1999 January 1, 0h UTC, to 2006 January 1 0h UTC : UTC-TAI = - 32s
from 2006 January 1, 0h UTC, until further notice : UTC-TAI = - 33s

Leap seconds can be introduced in UTC at the end of the months of December or June, depending on the evolution of UT1-TAI.

Information provided by: INTERNATIONAL EARTH ROTATION SERVICE (IERS), Paris, France

The Coordinated Universal Time (or UTC) replaced Greenwich Mean Time (GMT) as the reference time scale derived from The Temps Atomique International (TAI) calculated by the Bureau International des Poids et Mesures (BIPM) in Paris, France using a worldwide network of atomic clocks. UTC differs from TAI by an integer number of seconds; it is the basis of all activities in the world.

UT1 is the time scale based on the observation of the Earth's rotation. It is now derived from Very Long Baseline Interferometry (VLBI). The various irregular fluctuations progressively detected in the rotation rate of the Earth lead in 1972 to the replacement of UT1 as the reference time scale . However, it was desired by the scientific community to maintain the difference UT1-UTC smaller than 0.9 second to ensure agreement between the physical and astronomical time scales.

Since the adoption of this system in 1972, firstly due to the initial choice of the value of the second (1/86400 mean solar day of the year 1900) and secondly to the general slowing down of the Earth's rotation, it has been necessary to add 21s to UTC.

The decision to introduce a leap second in UTC is the responsibility of the International Earth Rotation Service (IERS). According to international agreements, first preference is given to the opportunities at the end of December and June, and second preference to those at the end of March and September. Since the system was introduced in 1972, only dates in June and December have been used.

Današnji časi...

International Atomic Time (TAI) is a statistical atomic time scale based on a large number of clocks operating at standards laboratories around the world that is maintained by the **Bureau International des Poids et Mesures**; its unit interval is exactly one SI second at sea level. The origin of TAI is such that UT1-TAI is approximately 0 (zero) on January 1, 1958. TAI is not adjusted for leap seconds. It is recommended by the BIPM that systems which cannot handle leapseconds use TAI instead.

Coordinated Universal Time (UTC) is defined by the *CCIR Recommendation 460-4 (1986)*. It differs from TAI by the total number of leap seconds, so that UT1-UTC stays smaller than 0.9s in absolute value. The decision to introduce a leap second in UTC is the responsibility of the **International Earth Rotation Service (IERS).** According to the CCIR Recommendation, first preference is given to the opportunities at the end of December and June, and second preference to those at the end of March and September. Since the system was introduced in 1972, only dates in June and December have been used. TAI is expressed in terms of UTC by the relation TAI = UTC + *d*AT, where *d*AT is the total algebraic sum of leap seconds.

The first leap second was introduced on June 30, 1972. The historical list of leap seconds can be found **here**.

The **Global Positioning System (GPS) epoch** is January 6, 1980 and is synchronized to UTC. GPS is NOT adjusted for leap seconds.

```
As of 1 January 2006,
        TAI is ahead of UTC   by 33 seconds.
        TAI is ahead of GPS   by 19 seconds.
        GPS is ahead of UTC   by 14 seconds.
```

Until 1960, Universal Time (UT) was taken as the independent variable of astronomical ephemerides. UT was then replaced by Ephemeris Time (ET), based on the motion of the sun. However, ET did not include relativistic effects, such as corrections for the gravitational potential and velocity, as required by advances in the accuracy of time comparisons. Thus ET was superseded in 1981 by Terrestrial Dynamical Time (TDT) and Barycentric Dynamical Time (TDB), which distinguish coordinate systems with origins at the center of the Earth and the center of the solar system, respectively, and are consistent with the general theory of relativity. In the language of general relativity, TDT is a proper time while TDB is a coordinate time. In 1991, TDT was renamed simply Terrestrial Time (TT) and two additional relativistic time scales, Geocentric Coordinate Time (TCG) and Barycentric Coordinate Time (TCB) were adopted. Definitions of these time scales are given in **Systems of Time.**

Definicije pojma “leto”

Astronomical years [edit]

Julian year [edit]

The **Julian year**, as used in astronomy and other sciences, is a time unit defined as exactly 365.25 days. This is the normal meaning of the unit "year" (symbol "a" from the Latin *annus*, *annata*) used in various scientific contexts. The Julian century of 36,525 days and the Julian millennium of 365,250 days are used in astronomical calculations. Fundamentally, expressing a time interval in Julian years is a way to precisely specify how many days (not how many "real" years), for long time intervals where stating the number of days would be unwieldy and unintuitive. By convention, the Julian year is used in the computation of the distance covered by a light-year.

Sidereal, tropical, and anomalistic years [edit]

The relations among these are considered more fully in Precession (astronomy).

Each of these three years can be loosely called an 'astronomical year'.

The **sidereal year** is the time for the Earth to complete one revolution of its orbit, as measured in a fixed frame of reference (such as the fixed stars, Latin *sidus*). Its duration in SI days of 86,400 SI seconds each is on average:

365.256 363 051 days (365 d 6 h 9 min 9 s) (at the epoch J2000.0 = 2000 January 1 12:00:00 TT).

The **tropical year** is the time for the Earth to complete one revolution with respect to the framework provided by the intersection of the ecliptic (the plane of the orbit of the Earth) and the plane of the equator (the plane perpendicular to the rotation axis of the Earth). The exact length of a tropical year slightly depends on the chosen starting point: for example the **vernal equinox year** is the time between successive vernal equinoxes. The **mean tropical year** (averaged over all ecliptic points) is:

365.242 189 67 days (365 d 5 h 48 min 45 s) (at the epoch J2000.0).

The **anomalistic year** is the time for the Earth to complete one revolution with respect to its apsides. The orbit of the Earth is elliptical; the extreme points, called apsides, are the perihelion, where the Earth is closest to the Sun (January 2 in 2000), and the aphelion, where the Earth is farthest from the Sun (July 2 in 2000). The average duration of the anomalistic year is:

Besselian year [edit]

The **Besselian year** is a tropical year that starts when the fictitious mean Sun reaches an ecliptic longitude of 280°. This is currently on or close to 1 January. It is named after the 19th century German astronomer and mathematician Friedrich Bessel. An approximate formula to compute the current time in Besselian years from the Julian day is:

$$B = 2{,}000 + (JD - 2{,}451{,}544.53) / 365.242189$$

Reforma koledarja

- Julijanski: leto = 365.25 dni.
- Do leta 1582 se je nabralo za 10 dni razlike, torej Gregorijanski z dolžino 365,2425 dni in 4. oktobru sledil 15. oktober.
- To blizu pravi dolžini leta, ki je 365,24219 dni.

Julijanski datum

- Astronomom gredo vsa ta prestopna leta in različne dolžine mesecev na živce, zato se ne uporablja datuma, ampak julijanski datum.
- Začetek 24. novembra 4713 pr.n.št. Po gregorijanskem koledarju (oz. 1. januarja 4713 pr.n.št po julijanskem).
- 26. oktober 2007 ob 0.00 UT je JD2454399.0.

Variante Julijanskega datuma

- The **Heliocentric Julian Day** (HJD) is the same as the Julian day, but adjusted to the frame of reference of the Sun, and thus can differ from the Julian day by as much as 8.3 minutes, that being the time it takes the Sun's light to reach Earth. The Julian day is sometimes referred to as the **Geocentric Julian Day** (GJD) in order to distinguish it from HJD.

  Because the starting point is so long ago, numbers in the Julian day can be quite large and cumbersome. A more recent starting point is sometimes used, for instance by dropping the leading digits, in order to fit into limited computer memory with an adequate amount of precision.

- The **Modified Julian Day** (MJD) is the number of days (with decimal fraction of the day) that have elapsed since midnight at the beginning of Wednesday November 17, 1858. In terms of the Julian day:

  MJD = JD − 2,400,000.5

  Currently the value is 2454399.79861 − 2400000.5 = 54399.29861.

  The day is found by rounding *downward*, currently giving 54399. This number changes at midnight UT or TT. It is 2,400,001 less than the Julian day number of the afternoon half of the same day (which is the same as the JD at noon). It is a multiple of 7 on Wednesdays.

  The MJD was introduced by the Smithsonian Astrophysical Observatory in 1957 to record the orbit of Sputnik via an IBM 704 (36-bit machine) and using only 18 bits until 2576-08-07. MJD is the epoch of OpenVMS, using 63-bit date/time postponing the next Y2K campaign to 31-JUL-31086 02:48:05.47.