
Time
Ast 401/Phy 580
Fall 2015

Time

- Solar Time
- Universal Time
- Sidereal Time
- Julian Date
- Heliocentric Julian Date

Solar Time

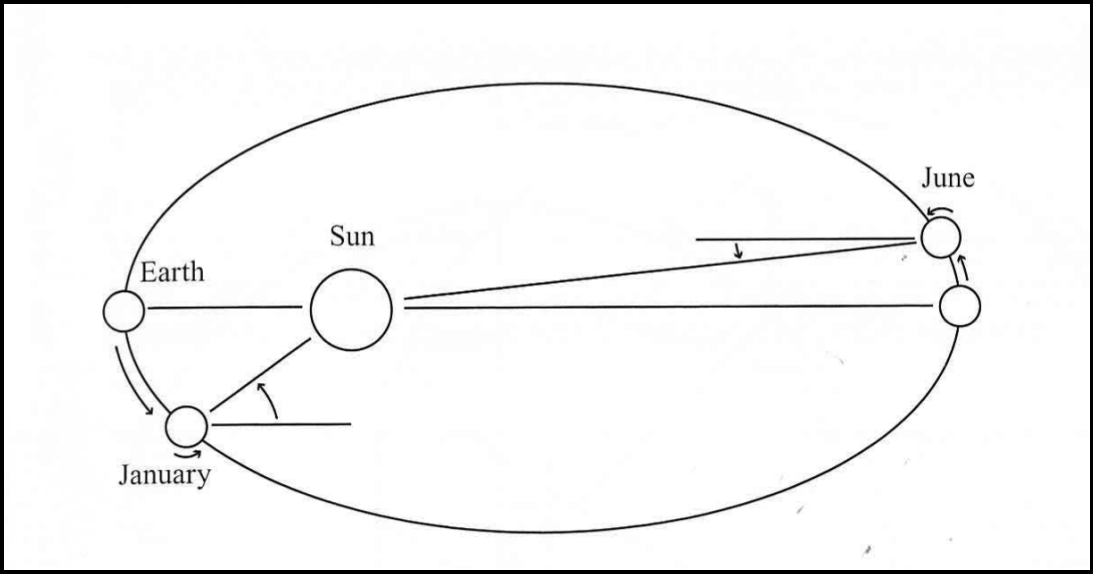
Local time is based (more or less) on when the sun crosses the meridian---noon!

Because of the railroads (etc) "time zones" were constructed so that it was the SAME time in each area (state in the US, country in Europe, etc)

But there's a complication...

Solar Time

The earth's orbit isn't circular. The earth has to turn MORE to have the sun on the meridian when it's closest to the sun (January) than when it's further away (June).



Solar Time

So, our "normal" 24-hour time is based on "mean solar" time, sort of an average.

Universal time

Astronomers try to keep it simple and report the time of observation as "universal time (UT)". This is the time in Greenwich, England, ignoring daylight savings time. It is always 7hr more than the time in Phoenix/Flagstaff (MST):

5am here = 12:00 UT

5pm here = 00:00 UT the following day

Convenient for US astronomers, as most of the night is a single date.

Universal time

You make an observation at the the DCT tonight (Sept 3) at 10pm local time. What date and time do you put down in your observing log?

A. 2015-Sep-03 05:00:00 UT

B. 2015-Sep-04 05:00:00 UT

C. 2015-Sep-03 06:00:00 UT

D. 2015-Sep-04 06:00:00 UT

Universal time

Local time in Chile is 3 hours later than in Flagstaff. The sun is going to set at 7pm Chilean time on September 3 and I can start observing around 8:00pm. What's the UT of my first observation?

A. 2013-Sept-03 23:00

B. 2013-Sept-03 00:00

C 2013-Sept-04 00:00

D 2013-Sept-03 01:00

Universal time

Local time in Chile is 3 hours later than in Flagstaff. The sun is going to set at 7pm Chilean time on September 3 and I can start observing around 8:00pm. What's the UT of my first observation?

A. 2013-Sept-03 23:00

B. 2013-Sept-03 00:00

C 2013-Sept-04 00:00

D 2013-Sept-03 01:00

Sidereal time

The earth is going around the sun, which means that a star will "rise" a bit earlier every evening.

(More accurate to say that the celestial sphere will be in the exact location a bit earlier every evening.)

The difference is about 1/365th of 24 hours, or 3min 56 sec. Keeping time based on a 23:56:04 day is Sidereal time.

Sidereal time

Why? The "local sidereal time" tells you the **right ascension of a star on the meridian.**

On September 21st, the LST at local midnight is 00:00.

If you remember that, you can figure out when your object is up just using your noggin!!!!!

- Each month is 2 hrs later in LST at midnight (24 hours / 12 months = 2 hours/month)

What is the RA of a star on the meridian at midnight on June 21?

A. 0hr

B. 3hr

C. 6hr

D. 12hr

E. 18hr

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D. 12hr

E. 18hr

You want to observe M31 (00:40 +40 deg), and it would help if it was up for most of the month. What's the optimal season to observe it?

A. Early Fall

B. Late Fall

C. Early Spring

D. Late Spring

E. Mid summer

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Sidereal time

How do we compute the exact LST for our observatory at a particular time?

- Need to know longitude of the observatory
- Need to know LST at Greenwich at midnight on that date
- Add (or subtract) the longitude (in hours, minutes, and seconds) to the LST at Greenwich at midnight, and then add in "a little bit more than" than the time. [REALLY???]

Julian Day

An observation of a binary star was made on (UT) 2009 December 12 at 05:15. Another observation was taken on (UT) 2012 June 10 at 04:30. How much time has elapsed?

2012 June 10 04:30 - 2009 Dec 12 05:15= ?????

Uh...30 days has September, April, June and November...all the rest have 31, but need to worry about leap years. Ugh!!!!!!

Julian Day

Julian days were invented to get around this problem. They are decimal days, starting at NOON UT on January 1, 4713 BC....Two and a half million days later, examples in book show how to compute this.

Example 2.4 Calculate the Julian Date from the Calendar Date (second example)

Find the Julian Date at 03:45 UT on August 21, 2020.

Again, we must calculate N, the number of days which have elapsed from the beginning of the year until August 21.

$$\mathbf{N = Int\left[\frac{275 \times 8}{9}\right] - 1 \times Int\left[\frac{(8+9)}{12}\right] + 21 - 30 = 234}$$

Note that because the year 2020 is a leap year, August 21 is the 234th day of the year instead of the 233rd day of the year as in Example 2.3.

Then L, the number of leap days which will have occurred between January 1, 2001, and January 1, 2020, is simply Int[(2020 − 2001)/4] = 4.

$$\text{JD} = 2\,451\,544.5 + 365 \times (2020 - 2000) + 234 + 4 = 2\,459\,082.5$$

Now, we must add the fraction of the day that has elapsed since 0^h UT.

$$3^h\,45^m = 3.75^h \quad \frac{3.75}{24} = \mathbf{0.156^d} \quad \text{JD} = 2\,459\,082.5 + 0.156$$

$$= 2\,459\,082.656$$

Julian Day

I prefer using http://aa.usno.navy.mil/data/docs/JulianDate.php

Julian Date Converter

Astronomical Applications Department

- Data Services
- Information Center
- Publications
- Software
- About AA

Calendar date to Julian date

Year: 2012 (•) CE ( ) BCE

Month: June **Day:** 10

Hour: 04 **Minute:** 30 **Second:** 0.0 Universal Time **(UT1)**

Compute Julian date

Julian date to Calendar date

Julian Date: 2456504.50000

Compute Calendar date

The Julian date for CE 2012 June 10 04:30:00.0 UT is
JD 2456088.687500

Back to form

Julian Day

2012 June 10 04:30 = 2456271.6875

2010 Dec 12 05:15 = 2455542.7188

subtract: 728.9687 days

Hmmm...but...wait...the earth was on the opposite side of the sun. Depending on where the star was, there could be a difference of 16 minutes in when the light reached the earth! 16 minutes=0.0111 days.

Heliocentric Julian Day

Really want HJD if you are keeping track of things that change! Depends upon the UT date and time PLUS the star's position. Math isn't hard but it IS messy. Use a canned program.

Quiz!

1. It's November 21 at midnight. What (roughly) will be the hour angle of the Andromeda Galaxy (RA=00:40, DEC=41°)?

2. What is the best couple of weeks to observe the Whirlpool Galaxy? (RA=13:30, DEC=+47°12')?

3. The Autumnal equinox occurs this year at 2015-Sept-23 08:22 UT. What local time (and date) will it occur in Flagstaff?

Homework assignment! Due Sept 15

1. Kathryn will be observing on the LMC (RA=05:00, Dec=-70°) on the Swope telescope on Las Campanas (Chile, latitude ≈-29°) on November 22 [1 month before Dec 22—hint!] At 2am local time in Chile, what will the hour angle of the LMC be?

2. In Flagstaff (latitude ≈+35°) you see a star about 45° above the southern horizon at 10pm on March 22. What is the star's approximate RA and Dec?

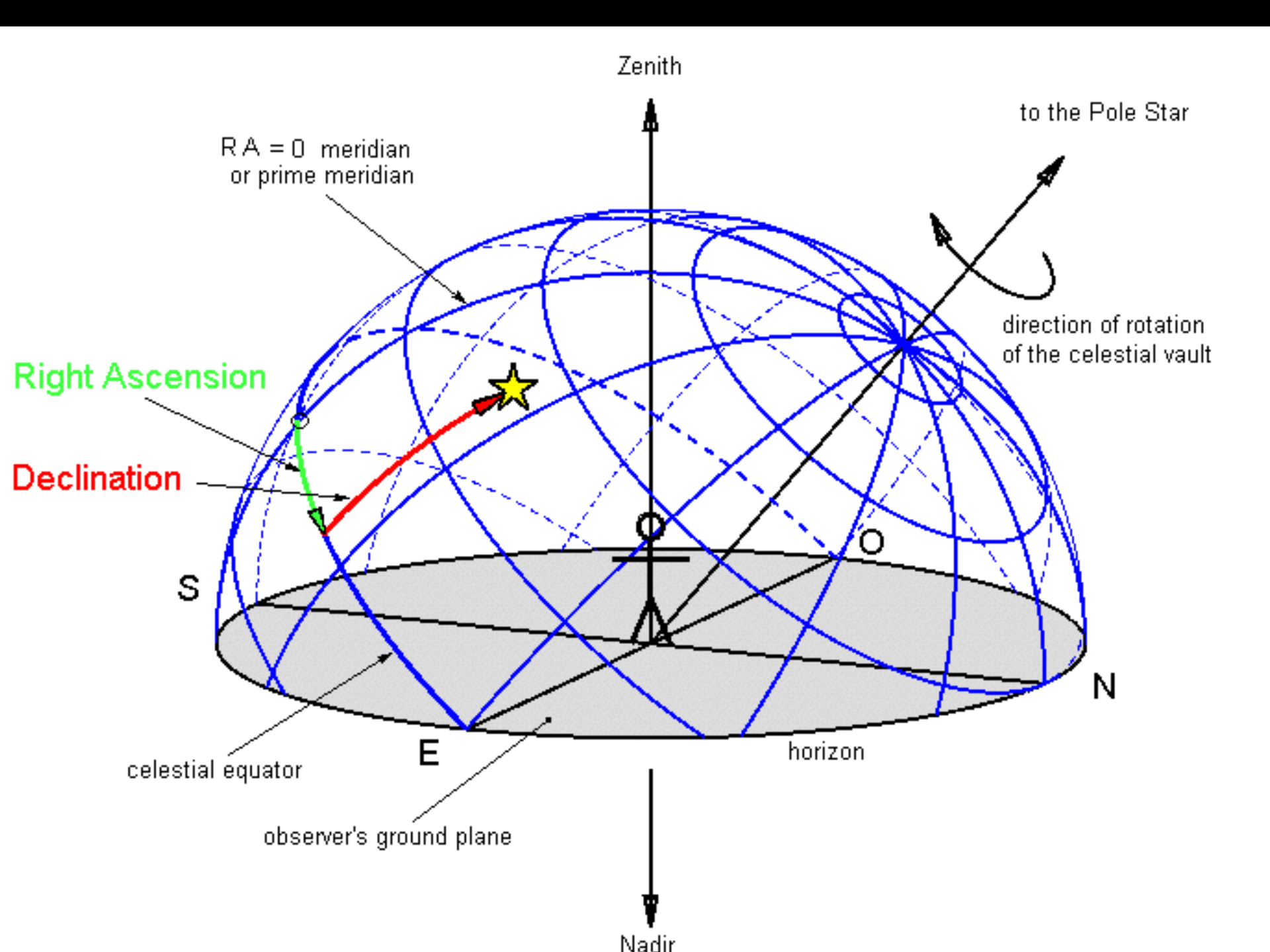
Having probelems with RA, DEC, ETC?

COORDINATES, TIME, AND THE SKY

John Thorstensen

Department of Physics and Astronomy

Dartmouth College, Hanover, NH 03755


Zenith
to the Pole Star
R A = 0 meridian
or prime meridian
direction of rotation
of the celestial vault
Right Ascension
Declination
O
O
S
N
E
celestial equator
horizon
observer's ground plane
Nadir