Astronomical Techniques I

Lecture 1

Yogesh Wadadekar

Jan-Feb 2015

Course Website

http://www.ncra.tifr.res.in:8081/∼yogesh/astrotech1_2015/

Best way to reach me is by email at *yogesh@ncra.tifr.res.in*
The PDF file for each lecture will be put on the website immediately after it is given. So, don't bother copying stuff that is already on the slide.

Introductions

Assessment

- 60% weightage for 2 assignments to be given at approximately the end of the third week and the sixth week.
- 25% weightage for paper review
- 15% for class participation.
- No exams!

Paper review

Choose a paper to study thoroughly and then give a 40 minute presentation on it at the end of the course, from the list at the course website. The list of papers (will appear on the website within a week) is quite varied so there should be something to suit every interest. If you wish to speak on a paper not on the list, send me email. Do discuss amongst yourselves, choose a paper no one else has chosen and let me know via email by Monday, 26 Jan 2015. If multiple people want to cover the same paper, we will need to resolve this amicably; get in touch with me.

Syllabus

09. Astronomical Techniques I (Incoherent Detection)

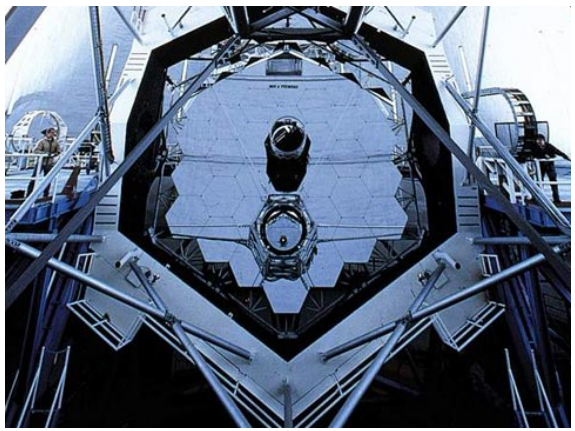
Time and coordinate measurements - Atmospheric effects (absorption, seeing, ...) - Basics of telescopes - Noise and statistics - Photon detectors - Basics of photometry - Spectroscopy and polarimetry.

Textbooks

Unfortunately, I cannot find one (or a few) textbooks that are both comprehensive and current. This is not the fault of the text book but the fault of the vast course content in this course. I have put up a (rather long) list of books that I am refering to that you may also find useful, on the website.

Questions ?

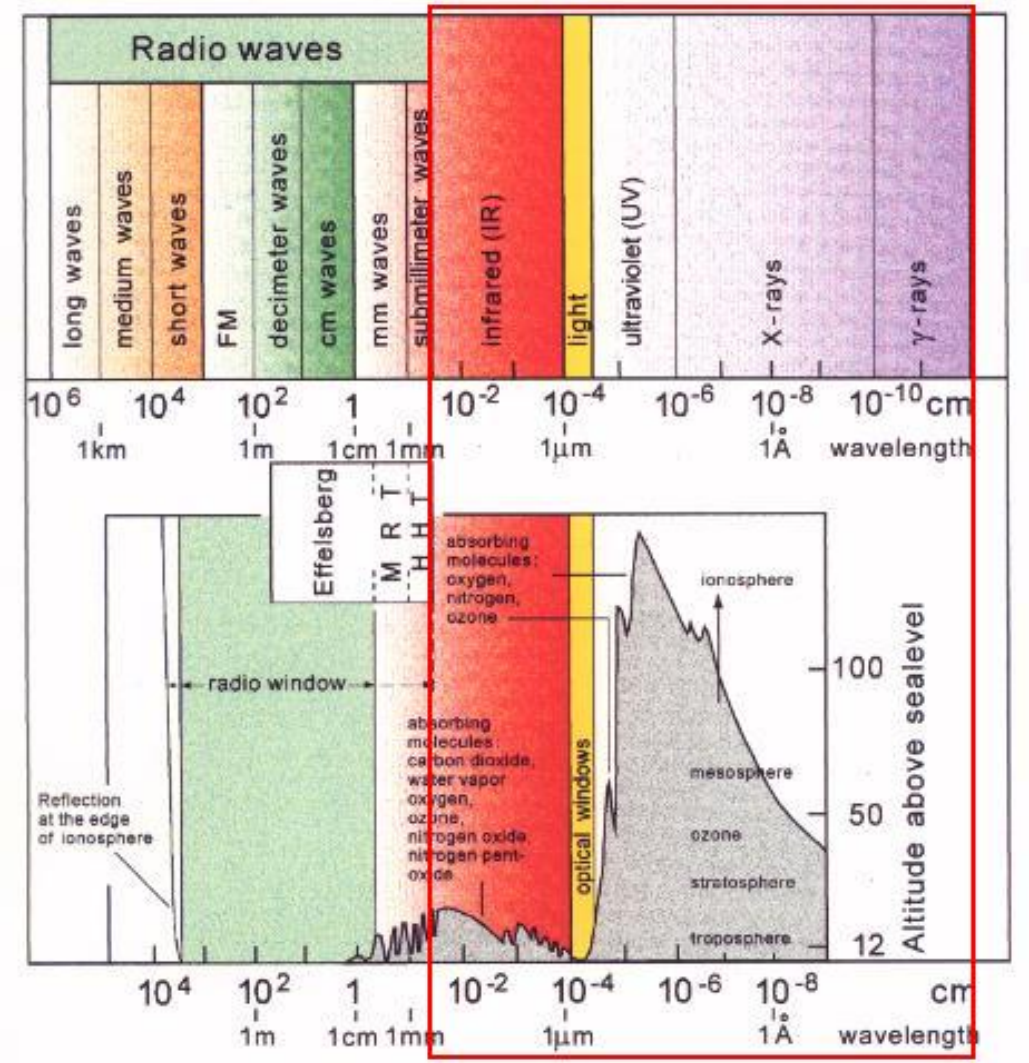
Incoherent-Coherent detection



(a) Incoherent

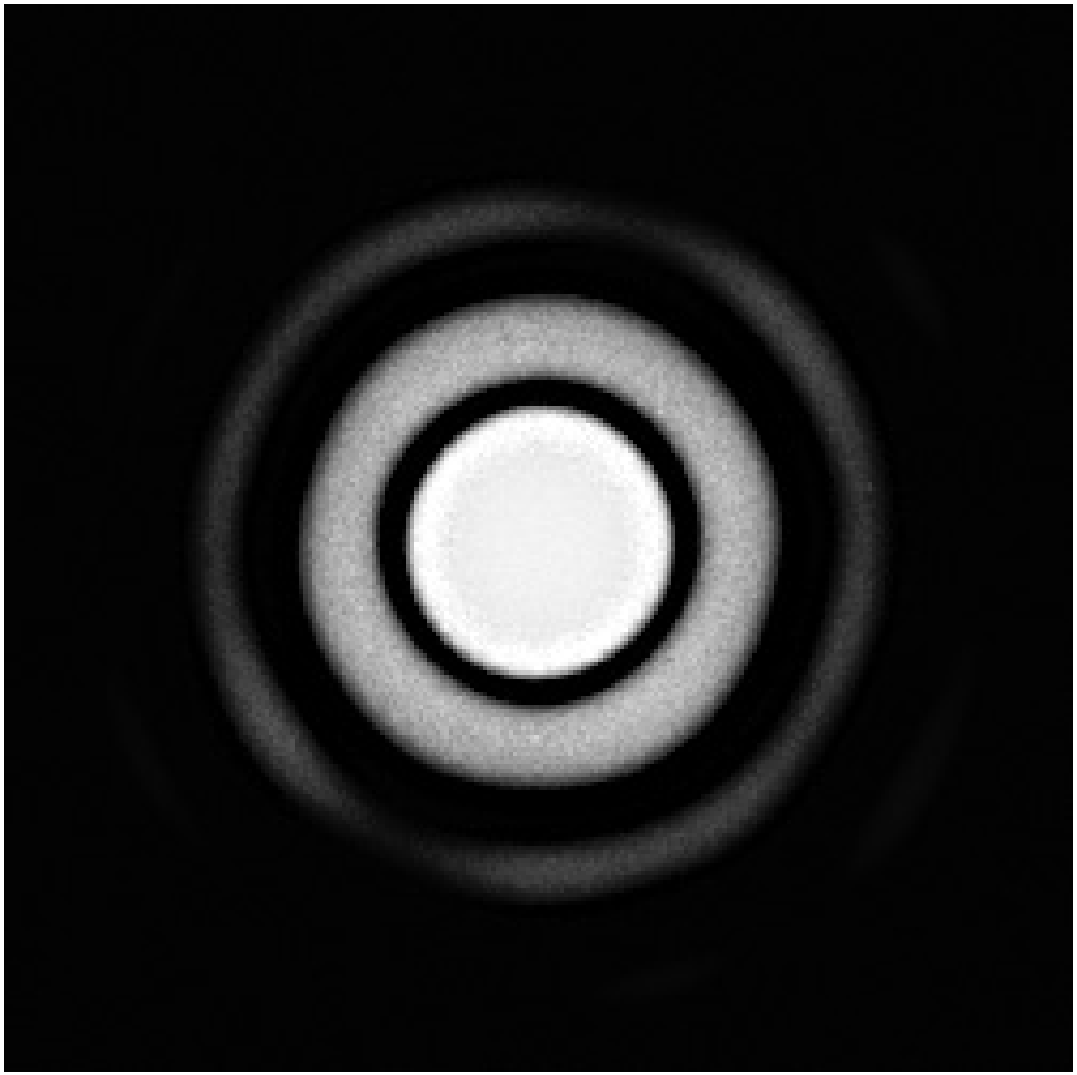
(b) Coherent

Wavelength regime covered in this course



Coherent-Incoherent division constrained by optics and electronics!

Wavelength between optical and radio



Solar Time

- Local time

Solar Time

- Local time
- Standard time

Solar Time

- Local time
- Standard time
- Greenwich time

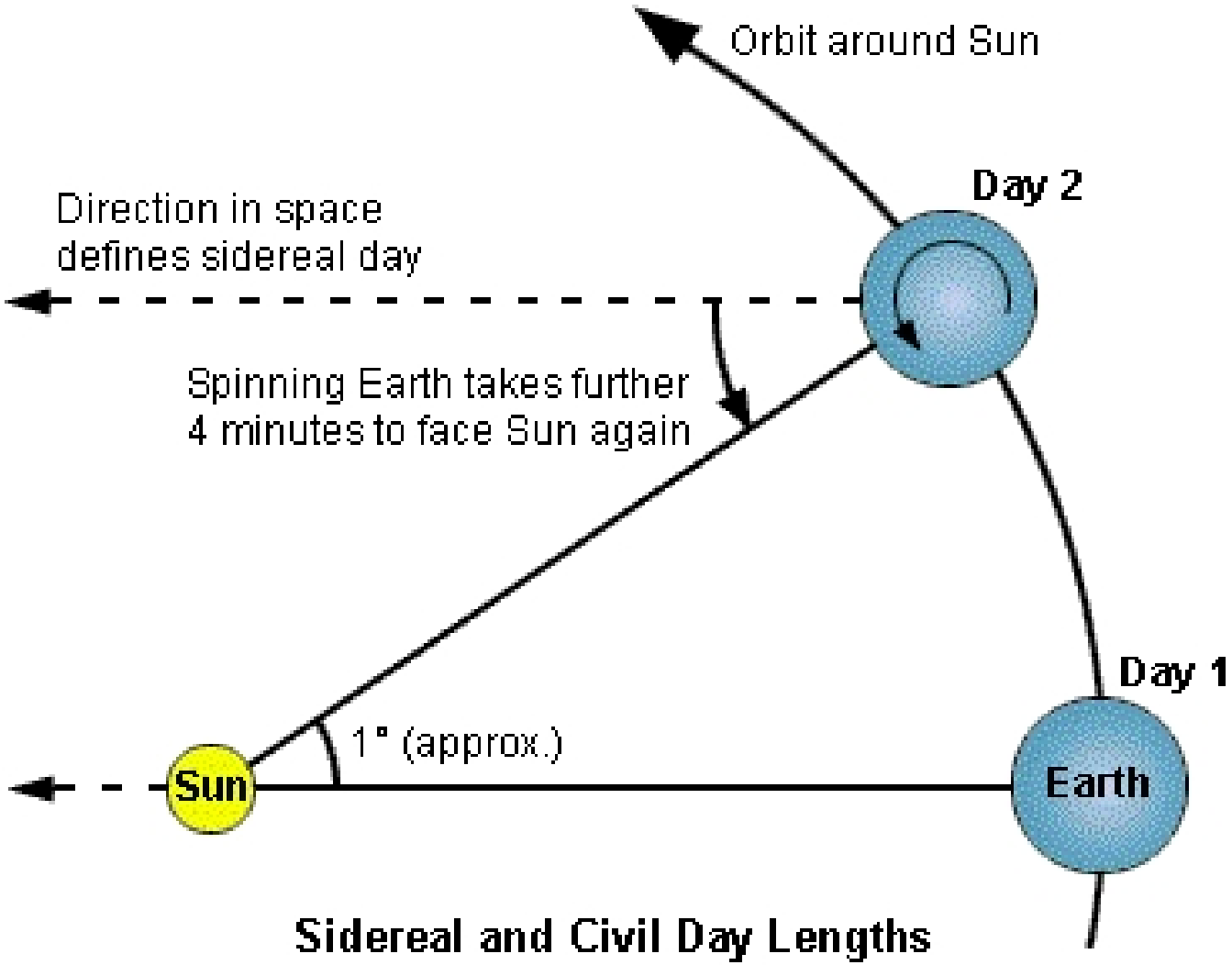
Solar Time

- Local time
- Standard time
- Greenwich time
- Universal time

Universal time

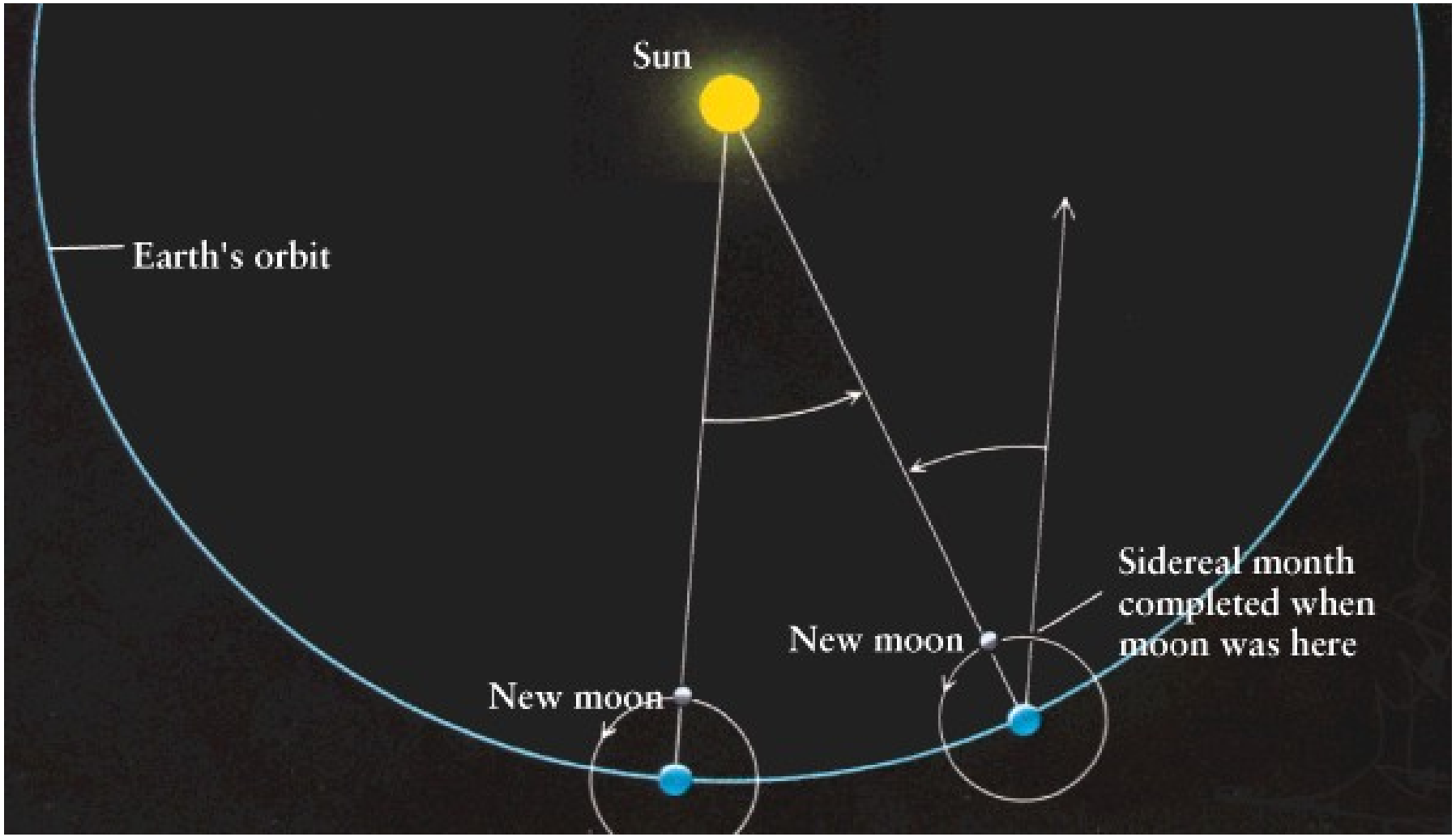
a generic reference to one of several time scales that approximate the mean diurnal motion of the Sun; loosely, mean solar time on the Greenwich meridian (previously referred to as Greenwich Mean Time). In current usage, UT refers either to a time scale called UT1 or to Coordinated Universal Time (UTC). UT1 is formally defined by a mathematical expression that relates it to sidereal time. Thus, UT1 is observationally determined by the apparent diurnal motions of celestial bodies, and is affected by irregularities in the Earths rate of rotation and needs correction. UTC is an atomic time scale but is maintained within 0s.9 of UT1 by the introduction of 1-second steps when necessary. Generally, leap seconds are added at the end of June or December as necessary, but may be inserted at the end of any month. Although it has never been utilized, it is possible to have a negative leap second in which case the 60th second of a minute would be removed.

Sidereal versus Solar Day



Could the sidereal day have been longer than a solar day?

Sidereal versus Synodic Month



Most lunar calendars use the Synodic month

Julian Day

- the interval of time in days and fractions of a day, since 4713 B.C. January 1, Greenwich noon.
- note that Julian day starts at noon. Why?
- Astronomers often use modified Julian day (MJD; starts at midnight!) or reduced Julian day (RJD)

Sunrise, Sunset

the times at which the apparent upper limb of the Sun is on the astronomical horizon. In The Astronomical Almanac they are computed as the times when the true zenith distance, referred to the center of the Earth, of the central point of the disk is 90 deg 50 min, based on adopted values of 34 arcmin for horizontal refraction and 16 arcmin for the Sun semidiameter.

Twilight

the interval of time preceding sunrise and following sunset during which the sky is partially illuminated. Civil twilight comprises the interval when the zenith distance, referred to the center of the Earth, of the central point of the solar disk is between 90 deg 50 min and 96 deg, nautical twilight comprises the interval from 96 to 102 deg, astronomical twilight comprises the interval from 102 to 108 deg

Year

- **Tropical year** (or solar year): the period of revolution of the Earth around the Sun with respect to the *dynamical equinox*. The tropical year comprises a complete cycle of seasons, and its length is approximated in the long term by the civil (Gregorian) calendar. It is approximately 365 days, 5 hours, 48 minutes, 45 seconds (365.2422 days).
- **Sidereal year**: the period of revolution of the Earth around the Sun in a fixed reference frame. It is the mean period of the Earths revolution with respect to the background stars. The sidereal year is currently approximately 20 minutes longer than the tropical year. Will our night sky in January 10000 AD look very different? Will it still be winter in January?
- **Anomalistic Year**: the period between successive passages of the Earth through perihelion. The anomalistic year is approximately 25 minutes longer than the tropical year.

Gregorian calendar

- The calendar introduced by Pope Gregory XIII in 1582 to replace the Julian calendar. This calendar is now used as the civil calendar in most countries. In the Gregorian calendar, every year that is exactly divisible by four is a leap year, except for centurial years, which must be exactly divisible by 400 to be leap years. Thus 2000 was a leap year, but 1900 and 2100 are not leap years.
- (365 * 400 + 100 - 3)/400 = 365.2425

Equation of time - the fictitious mean sun

Some questions to ponder

- What is the shortest day of the year?
- When is the earliest sunset?
- When is the latest sunrise?
- Why are these 3 dates not coincident?
- And how is this connected to the fact that the time shown by the Samrat Yantra at IUCAA needs a correction that depends on the time of year?