

**Why is it 20:00:00, Wednesday 21<sup>th</sup>  
November 2007?**

**David Malone <dwmalone@maths.tcd.ie>**

**Hamilton Institute, NUI Maynooth.**

**School of Mathematics, TCD.**

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## 2007: The Year

Seasons: Weather cycles, days lengthen and shorten.

Aim of our calendar: Keep Equinoxes and Solstices at the right time of year, especially the vernal equinox. Tricky: year isn't whole number of days (365.24219).

**The time of year:** angle between earth's axis and the line from the earth to the sun.

NB: seasons nothing to do with distance to sun. Earth is at its closest (Perihelion) about 3<sup>rd</sup> January 2008.

## Counting Years

Count years from the (supposed) year of Christ's birth.

Dionysius Exiguus (AD 523) asked to produce table of Easter Dates.

Unfortunately, Herod died in 4BC, so Dionysius probably got it wrong.

BC dating came somewhat later, along with the missing year zero.

Before that dates were counted since the founding of Rome. 1AD = 754AUC (ab urbe condita).

## November: The Month

Need bigger division of years than just days. Moon's phases is next most obvious thing in the sky.

Months roughly to be in sync with the moon (29.5305889 days)? Other calendars are better in this respect.

We've ended up with funny months.

Story says Romulus gave 10 months, a successor added 2 more.

## Julian Reform

|            |    |      |            |    |    |
|------------|----|------|------------|----|----|
| Ianuarius  | 29 | 31   | Quinctilis | 31 | 31 |
| Februarius | 28 | 28/9 | Sextis     | 29 | 31 |
| Martius    | 31 | 31   | September  | 29 | 30 |
| Aprilis    | 29 | 30   | October    | 31 | 31 |
| Maius      | 31 | 31   | November   | 29 | 30 |
| Iunius     | 29 | 30   | December   | 29 | 31 |

Old leap: Cut Feb at 23/24, intercal of 27 days, irregular.

New leap: Once in 4, double Feb 24.

Took a 445 day year, and some fumbling to get there.

Aiming for 365.24219 day year.

| When   | Calendar  | Length               |
|--------|-----------|----------------------|
| ????   | old roman | $355 \pm \text{£££}$ |
| 45BC   | Julian    | 365.25               |
| 1582AD | Gregorian | 365.2425             |

Papal Bull of 24 Feb 1582: 4 Oct followed by 15 Oct.

Equinox back at 21 Mar.

Took a while to catch on: 1752 for us.

# Wednesday: Day of Week

7 day week is very old. Ptolemaic week by Romans and biblical week by Jews.

| Portuguese    | English   | French   | Planet  |
|---------------|-----------|----------|---------|
| domingo       | Monday    | lundi    | Moon    |
| segunda-feira | Tuesday   | mardi    | Mars    |
| terça-feira   | Wednesday | mercredi | Mercury |
| quarta-feira  | Thursday  | jeudi    | Jupiter |
| quinta-feira  | Friday    | vendredi | Venus   |
| sexta-feira   | Saturday  | samedi   | Saturn  |
| sábado        | Sunday    | dimanche | (Sun)   |

Possibly longest unbroken tradition. Resisted French and Communist reform.

# Days

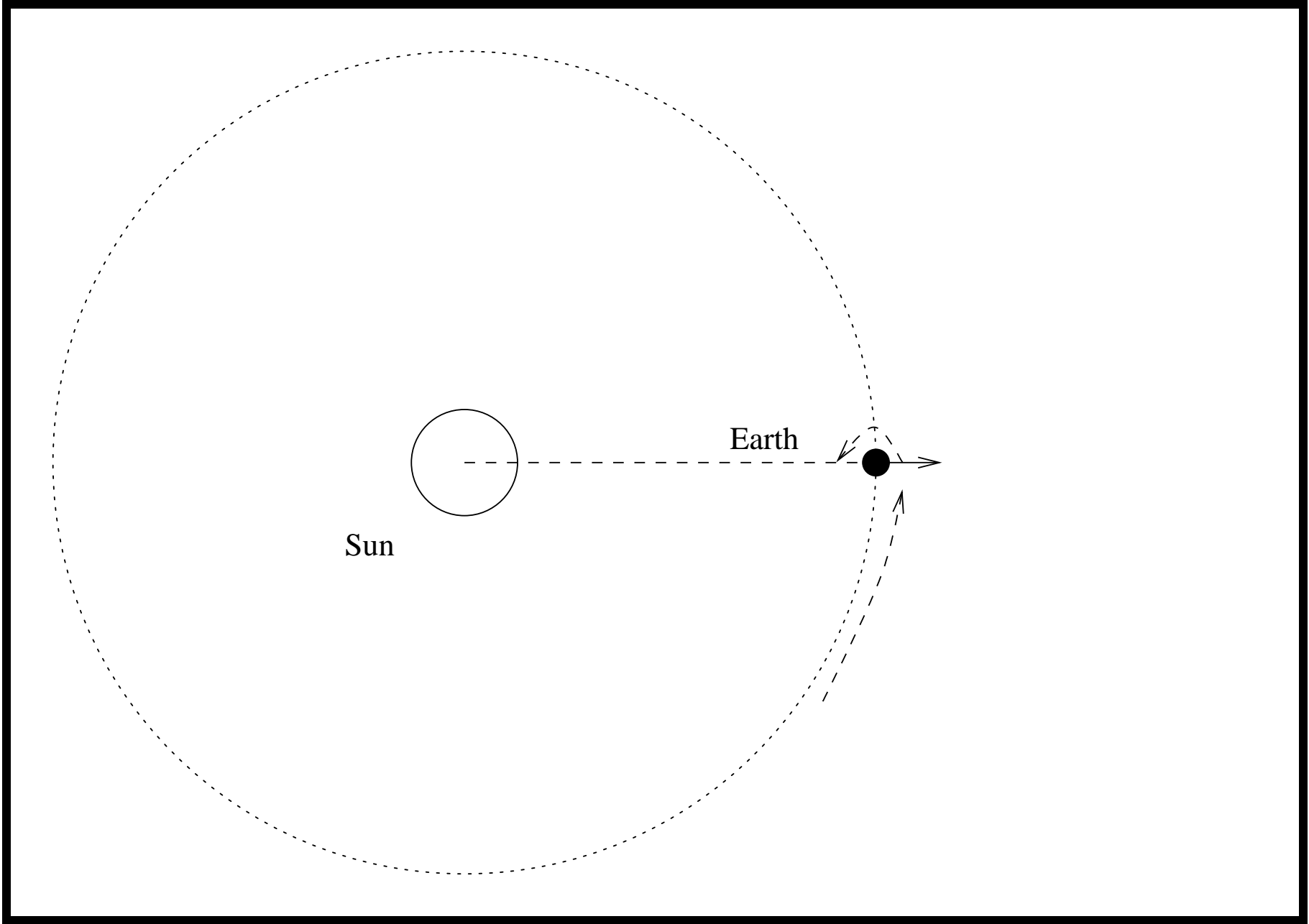
Obviously, it gets dark and bright once per day!

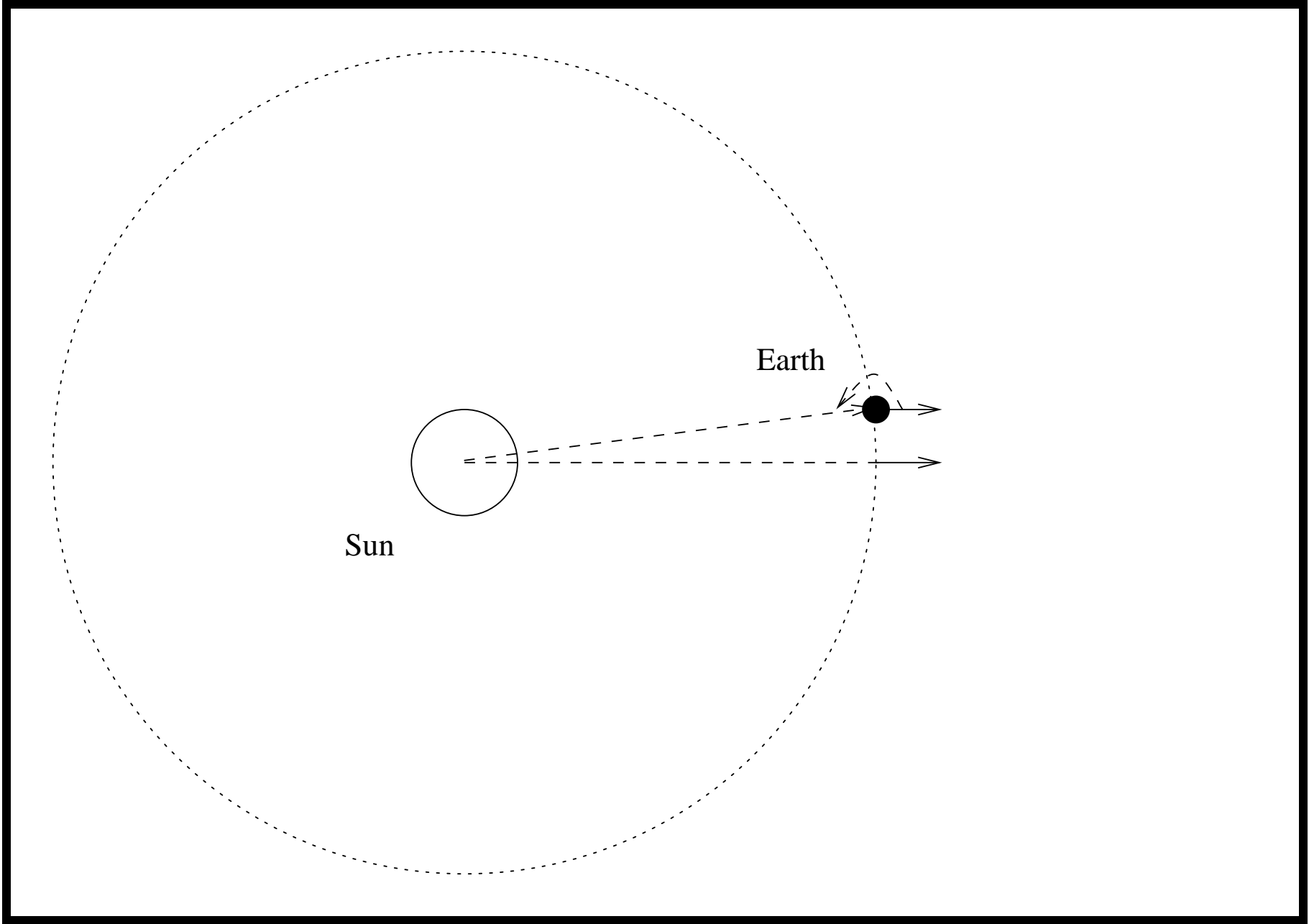
Different cultures start days at: sunset, sunrise, midnight, midday, ...

Must be something to do with Earth going around.

Solar vs. sidereal days.







## Hours

Pretty arbitrary divisions of a day. They arise by dividing things into 12.

Were very uneven. Gradually fixed (14C).

Came to us via monastery and Roman army.

In 7C, lots of subdivisions, by middle ages we have *minutae primae* and *minutae secundae*.

## Irish Legal time

Problem with midnight — it depends where you live.

In 1858, case law chooses local time.

In 1880, legislation fixes GMT in England, DMT in Ireland.



Dunsink Observatory  
made necessary measurements.

Usher: 25m7–48s (1787).

Brinkley: 25m22s (1832).

Romny-Robbinson:  
25m21s (1838).





## Legal Time Since

1916 Move to GMT with GB

1916 Daylight saving

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1923 Western-European Time

1968 Standard Time (GMT+1)

1971 Changed mind?

1986 Order giving effect to EEC directive

2001 2000/84/EU directive currently in force

In this Act the expression ‘West-European time’ means Greenwich mean time.

## Seconds: Universal Time

All in terms of GMT. There's a problem...

... GMT is dead!

*Universal Time* is calculated from sidereal time (now ERA) using a formula like this:

$$86636.55536790872 + 0.000005098097T \\ + 0.0000000000509T^2$$

(A day is usually 86400 long).



## Atomic Seconds

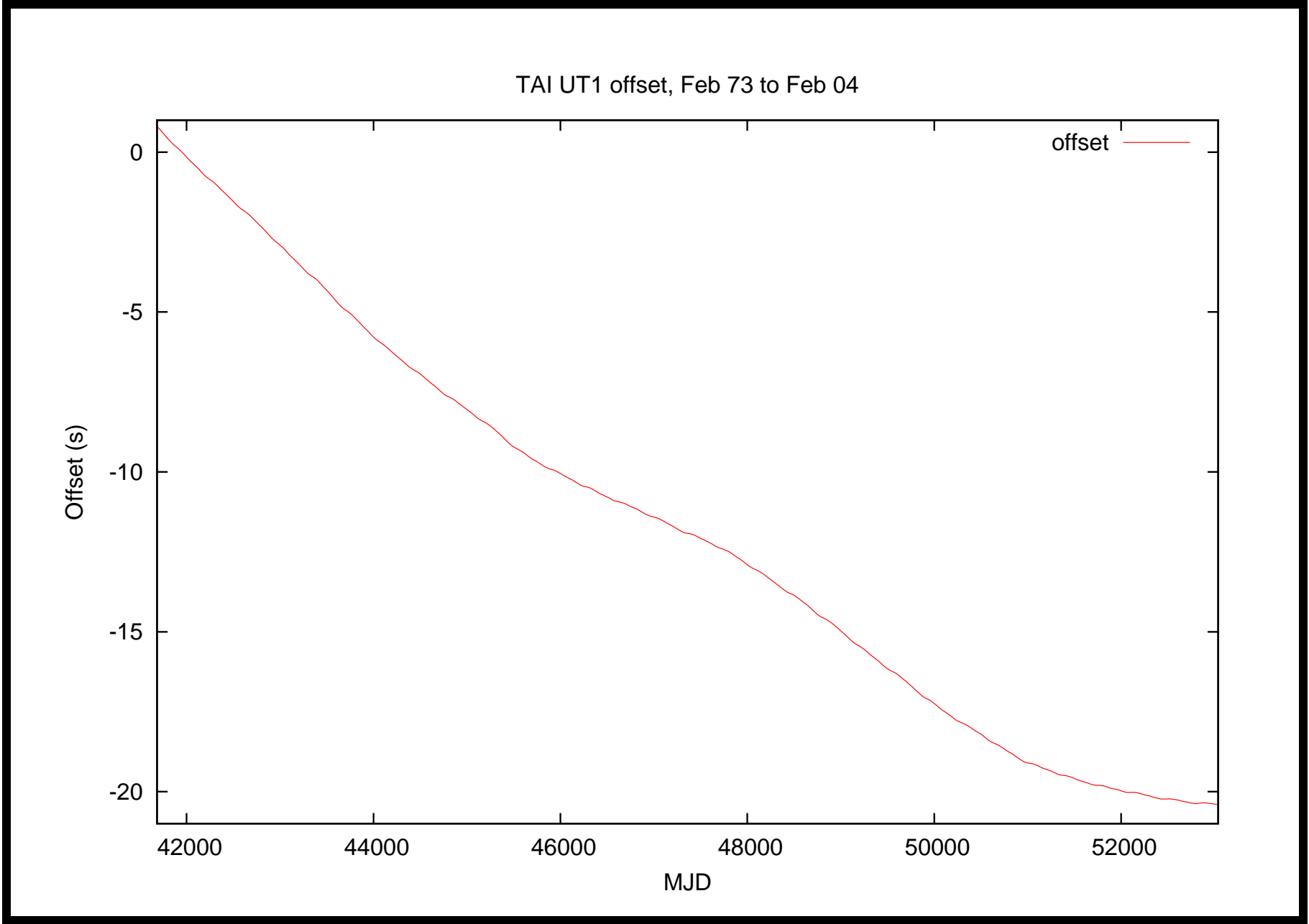
*International Atomic Time* has been available since 1955 (officially since 1972). Uses SI second.

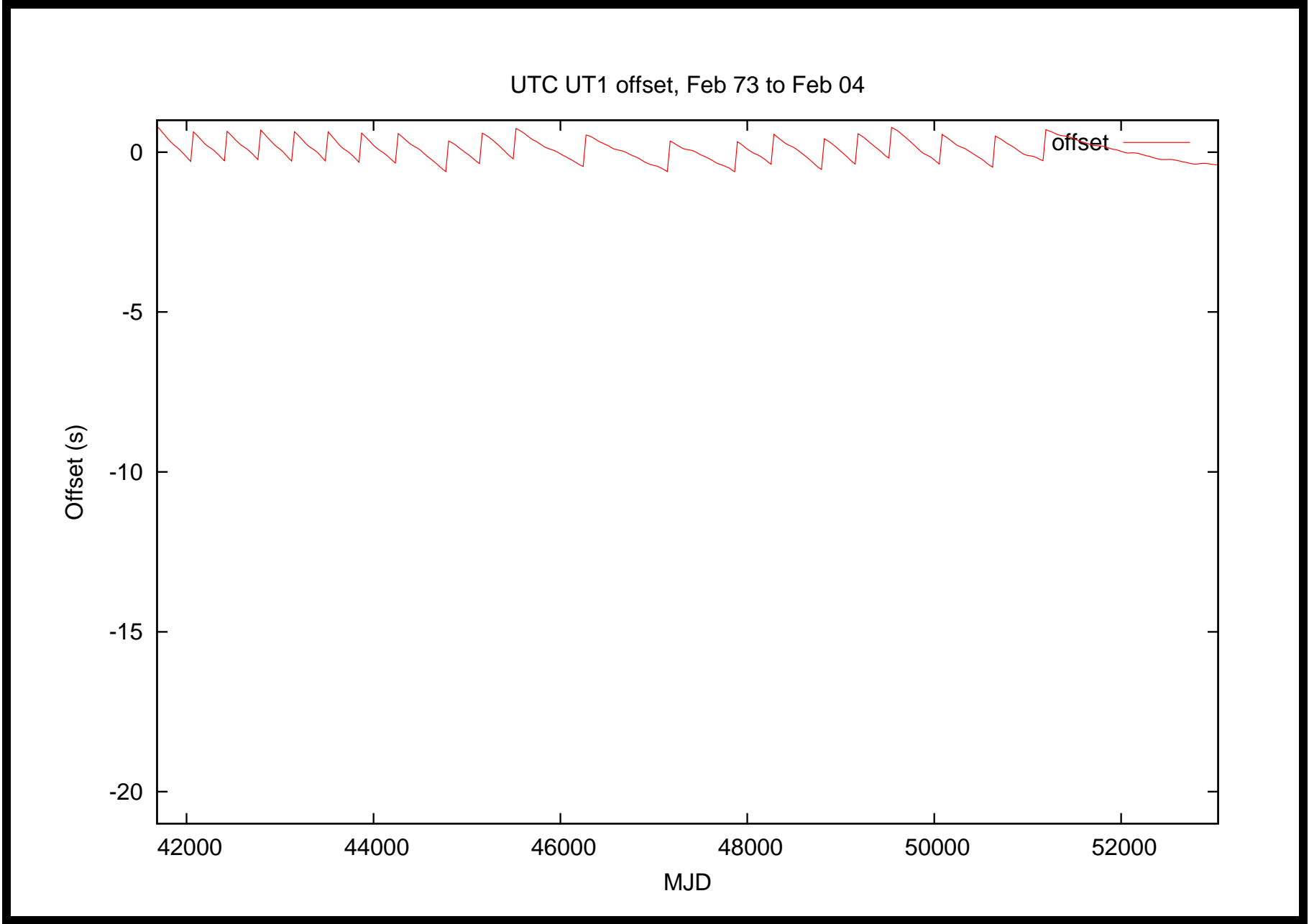
**second:** In the International System of Units (SI), the time interval equal to 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom.

Problem is that UT seconds and SI seconds are different.

*Coordinated Universal Time* is a compromise. It ticks once per SI second, in sync with TAI.

If UTC is more than one second from UT1 then UTC is adjusted.





## Pros

- Keeps UTC in sync with mean day.
- Preserves legal status-quo.
- Needed by astronomers and navigators.

## Cons

- Subtracting dates is hard or impossible.
- Makes software more complex.
- Misapplication could be dangerous.

## Final Thought

The Earth is not a good timekeeper.

vs.

The Earth is what we are trying to measure.