

How to Tell the Time!

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2021: Calendar 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).

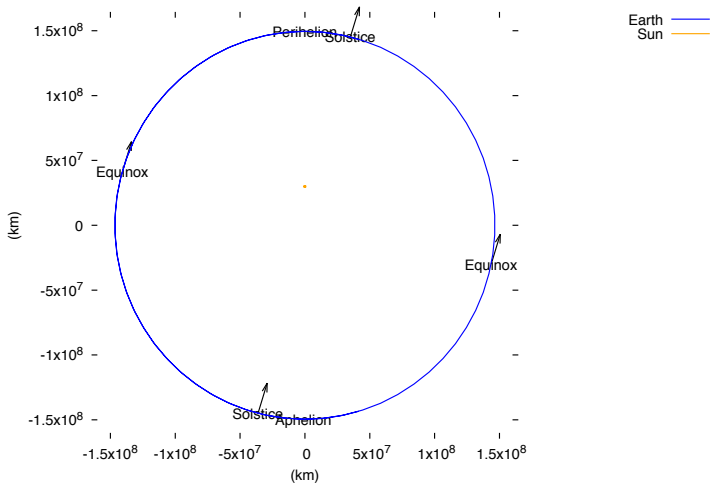
The time of year: angle between earth's axis and the line from the earth to the sun.

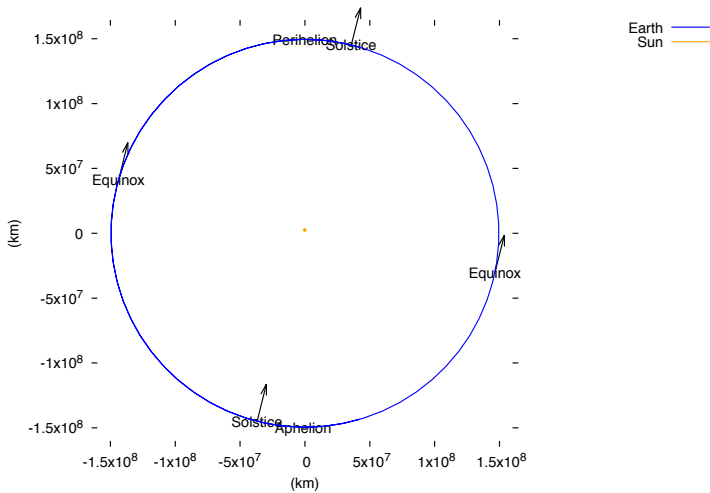
NB: seasons nothing to do with distance to sun. Earth is at its closest (Perihelion) about 2nd January 2021.











Counting Years

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

Dionysius Exiguus (AD 523) produced new table of Easter Dates.

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

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

Before that dates counted since the founding of Rome?

1AD = 754AUC (ab urbe condita).

April: Calendar 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, Numa, 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, *intercalarius* of 27 days, irregular.

New leap: Once in 4, double Feb 24.

Took 445 day year (46BC), and fumbling to get there (8AD).

(Astronomical events a useful retrospective!)

Aiming for 365.24219 day year.

| When | Calendar | Length |
|--------|-----------|-----------|
| ???? | Old Roman | 355 ± €€€ |
| 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.

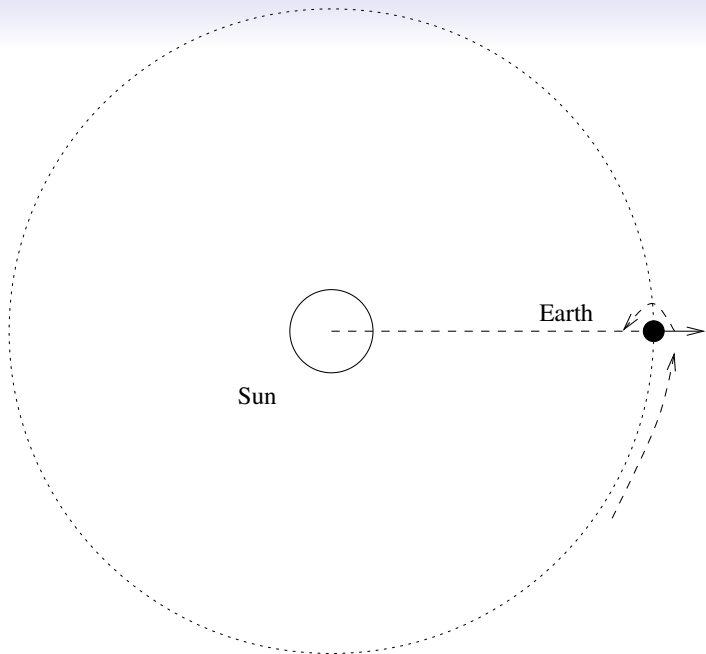
Days

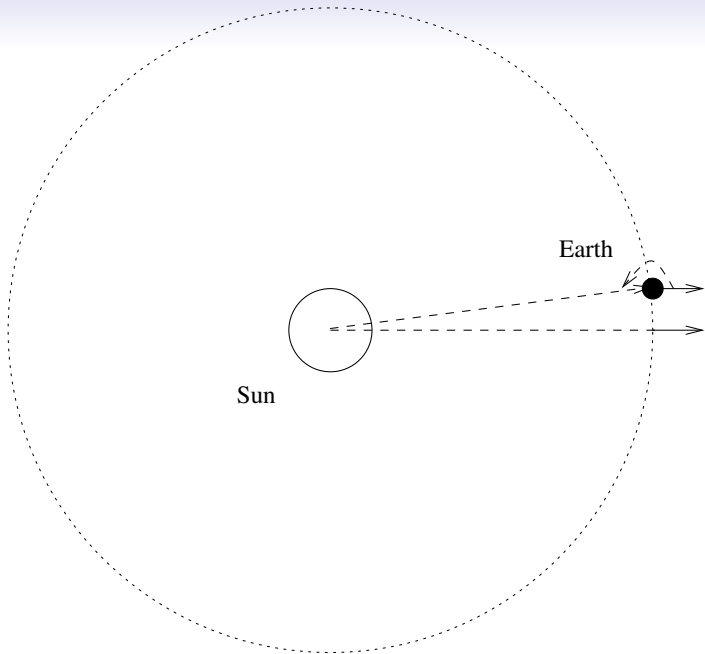
Obviously, it gets dark and bright once per day!

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

Must be something to do with Earth going around.

Solar vs. sidereal days.





Hours

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.
(Crawford Observatory was built in 1878.)



Dunsink Observatory

Usher: 25m7–48s (1787).

Brinkley: 25m22s (1832).

Romney-Robinson: 25m21s (1838).

Elliott-(Ray-Drury-

Malone): 25m21.02s (2017).

Legal Time Since

| | |
|--------|---|
| 1916 | Busy year for Ireland |
| 1923 | Western-European Time |
| 1941–5 | No double Summer Time |
| 1947 | No double Summer Time |
| 1968 | Standard Summer Time (GMT+1) |
| 1971 | Changed mind. |
| 1986 | Order giving effect to EEC directive |
| 2001 | 2000/84/EU directive currently in force (from 2002 last Sun in March/October, 1AM GMT) |

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:

$$86636.55536790872 + 0.000005098097 T \\ + 0.000000000509 T^2$$

(A day is usually 86400 long).

Atomic Seconds

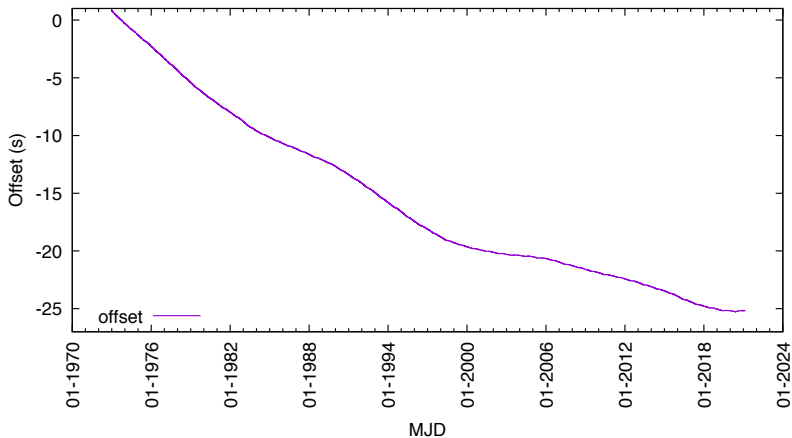
International Atomic Time has been available since 1955 (officially since 1972). Uses SI second.

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.

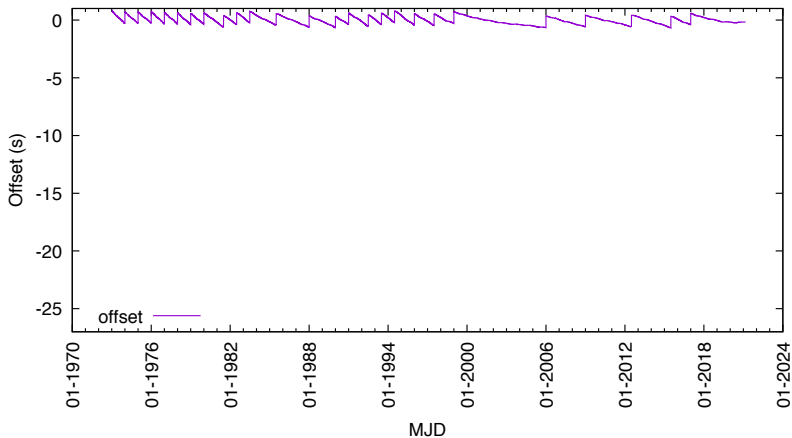
Coordinated Universal Time is a compromise. It ticks once per SI second, in sync with TAI.

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

TAI UT1 offset, Feb 73 to Apr 21



UTC UT1 offset, Feb 73 to Apr 21



Conclusion

- Thousands of years of clock and calendar reform.
- It's rarely as easy as it looks¹.

¹<https://qntm.org/abolish> and <https://qntm.org/calendar>, but think Brexit.

Monday: Day of Week

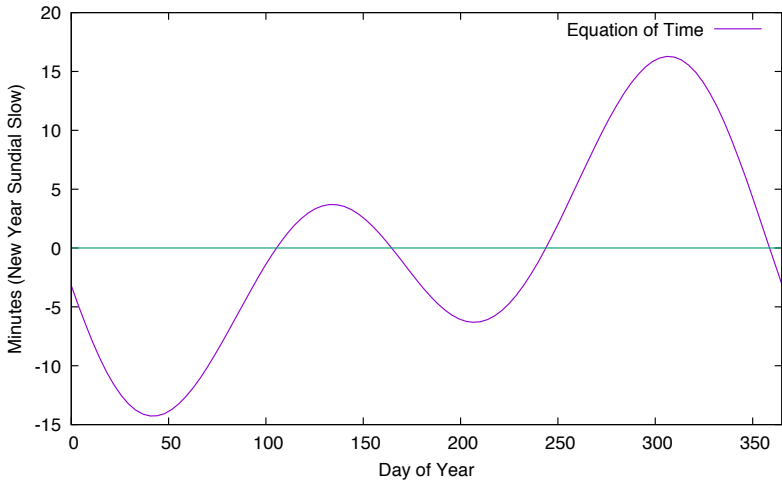
7 day week is very old. Ptolemaic week by Romans and biblical week by Jews.

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

Possibly longest unbroken tradition. Resisted French (10 day) and Communist (5 then 6 day) reform.

Apparent vs. Mean Time

In 1792, move from apparent time to mean time.



How did they pick 9,192,631,770?

Used ET, based on Newcomb's measurements from 1750–1892.

Tidal forces (1.7ms/d/c) mean UT and SI seconds are different (by 2.5ms).

What next?

Could Brexit have an effect?

However, there's also an argument about daylight savings.

The EU has been regularly reviewing the situation (2007, 2014, 2018) and might do something.

Choices Ahead

Summertime

- Sunrise after 9:30 for 1–2 months (light, frost, ...).
- Tried it before — not popular *Bloody Stupid Time*.
- Russians tried it 2011–2013.
- Bad for you?
- Could get New Year before London.

Wintertime

- 2 hour gap to Europe?
- Shorter stretch in the summer, winter no worse than now.
- Less time in the evening for activities.

DST

- Some health impacts.
- What about Northern Ireland?
- What about the EU?

Implementing a Change

Originally to be implemented by October 2019.

1. Decide what you want to do (with all your EU neighbours).
2. Is the global result sensible?
3. Pass an EU directive, implement local legislation.
4. Update Olsen Timezone database.
5. Microsoft/Apple/... update Windows/iOS/ ...
6. Find computers set to Dublin/London/Lisbon timezone.
7. Automatically update computers, phones, tablets, TVs, ...
8. Figure out what to do with Rugby/Frankfurt radio signals.

Negotiation with new Council of Ministers to happen, followed by final decision. Possible by March 2021?