Duncan Steel

The proper length of a calendar year

In recent times many misleading statements have appeared in books, newspapers and magazines concerning the proper length of a calendar year. The item by Iftikhar Ahmad (2002), which appeared in a recent issue of this journal, is the latest amongst them. His discussion is based on an entirely false supposition: that the target year length for the Gregorian calendar is the (mean) tropical year.

There exists an infinite number of possible tropical year lengths, corresponding to the infinite variety of start and end points on the Earth's orbit along the tropical zodiac (i.e. the ecliptic). The specific tropical year as employed in modern astronomy is in effect an average over all of them; it is defined to be the time the mean longitude of the Sun takes to increase by 360° (Seidelmann 1992, Meeus and Savoie 1992). Currently its duration, to six decimal places, is 365.242190 days, and many people have incorrectly made assessments of the presumed "accuracy" of the Gregorian calendar, of average year length 365.242500 days precisely, by comparing these figures. One of the earliest to suggest on this basis that a "correction" of one day every several millennia would be required was John Herschel, in his *Outlines of Astronomy* (1849). This is simply wrong.

The Gregorian calendar is an ecclesiastical calendar that was introduced in order to amend the Easter computus. In terms of year length, its reference point is the vernal equinox. Therefore the target year length is the time between passages through the vernal equinox which, again to six decimal places, is currently 365.242374 days (Meeus and Savoie 1992).

That is the yardstick by which the performance of the Gregorian calendar should be assessed. Obviously it does rather better than most authors believe. I have discussed this matter and related issues at far greater length elsewhere (Steel 2000). It is unfortunate that another recent paper (Sagarin 2001) has confused the mean tropical year with the vernal equinox year.

Further, the vernal equinox year happens to be slowly increasing, and at a rather lower rate than the tropical year is decreasing, making it comparatively stable. The arguments of Iftikhar Ahmad with regard to making calendrical corrections in the distant future are specious, on this and other grounds (e.g. the changing length of the day).

The reader might imagine that I am simply being pedantic, but the year length is a matter provoking much long-term and continuing religious argument. Although a few of the Eastern Orthodox churches have adopted the Gregorian calendar, most have not. Of the latter, many continue to use the Julian calendar, while some claim to have adopted the Revised Julian calendar in the 1920s. This employs, at present, the same dates as the Gregorian calendar but, rather than dropping three leap years in four centuries, it drops seven over nine centuries. There is no difference until in the Revised Julian the year AD 2800 would be a common year of 365 days, and AD 2900 would be leap. It is claimed that this is superior to the Gregorian scheme, on the basis that 218/900 = 0.242222 (seven leap years dropped out of 225) is closer than 97/400 = 0.2425 to the fraction of a day in a tropical year. But the argument is spurious because the correct target is close to 0.2424 (i.e. the vernal equinox year), so that the Gregorian calendar actually does better than the Revised Julian in this sense.

The target year length for any calendar depends on the overriding concerns of the society involved. For instance the Hebrew calendar (and also the short-lived French Revolutionary calendar) uses the autumnal equinox as its fundamental reference point, and so the autumnal equinox year (365.242018 days at present) is its target.

Many non-Christian societies use the vernal equinox as their annual fiduciary point, such as in the Persian or Jalaali calendar (see Borkowski 1996, Steel 2000). Although that calendar is rule-based, for an extended period in the past (and to come) the leap year cycle employed has consisted of eight leap years spread over 33 years in all (seven quadrennia followed by one quinquennium). This results in an average year length of 365.242424 days, and so the Jalaali calendar is of substantially greater precision than the Gregorian.

It also has another important advantage. In this 33-year cycle the instant of the vernal equinox varies by less than 24 hours, whereas within the Gregorian 400-year cycle the range is 53 hours. We are currently in the middle of that range, the latest equinox having been in 1903, the earliest being due in 2096. This equinoctial shift on the calendar may in part be responsible for claims that spring is coming earlier due to global warming, as discussed by Sagarin (2001). It is true that spring, as defined astronomically by the vernal equinox, is indeed coming earlier, but that is due to the leap year cycle employed.

Leaving this aside, many might think that an arguable length for a year would be the cycle of the seasons. Thus I close by noting that an analysis of temperature records indicates that for most northern hemisphere sites the annual cycle from when records began in the 17th century through until 1920–40 was the anomalistic year of 365.2596 days (Thomson 1995). Since then that cycle has broken down, perhaps due to global warming, or perhaps because the line of apsides has shifted sufficiently far away from the near alignment with the line connecting the solstices since they were coincident about 750 years ago. If the anomalistic year were used in devising a calendar, then apart from a quadrennial leap year an extra day every century (a 367-day year) would be required. I am definitely not making any suggestion for its adoption, however.

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Guenther Eichhorn

Physics on ADS

Readers should note that NASA's Astrophysics Data System, widely used in astronomy, has now expanded to include an extra 30 0000 physics abstracts from nine journals, including *Physical Review A–E* and *Physical Review Letters*. The ADS has also received comprehensive lists of references from those journals.

ADS is online at: adswww.harvard.edu/.

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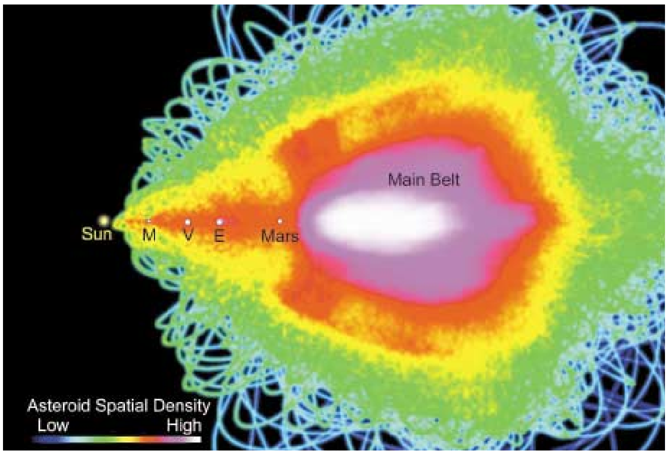

Density of known asteroids (by Scott Manley from *Target Earth* by D Steel).

Arthur C Clarke

The naming of Spaceguard

I was happy to see the reference to Spaceguard in the article "Bringing NEOs into focus". I invented this name in *Rendezvous with RAMA* (1973), as was pointed out in NASA's SPACEGUARD survey.

I'm still spooked by the fact that the date I chose in the novel for the catastrophe that led to SPACEGUARD's establishment was – September the 11th!

Sir Arthur C Clarke.