The "Phase-of-the-Moon" paradox in uncertainty estimation

Analytical Methods Committee, AMCTB No 61

In chemical measurement, many extraneous influences affect the magnitude of an analytical signal and thereby contribute to the uncertainty of the result. Some of these influences are predictable: others can be quite unexpected, the weather for example. Atomic spectrometry can be affected by gusts of wind that cause pressure changes in the fume extraction system. That makes the flame or plasma move relative to the instrument optics. There are tales of a spectrography laboratory where precision was degraded on the mornings when cleaners had applied a wax polish to the floor. The solvent of the polish contained enough UV-absorbing compounds to attenuate the light transmission in air-path spectrometers. But the phase of the Moon is predictable and any conceivable effect it could have on measurement uncertainty can be derived from physics.

Strictly, however, it is the position of the Moon in the sky (not the phase) that can affect the weight of an object, just as it affects the tides through the varying direction of its gravitational force. This in turn affects the determination of mass, and therefore of concentration. Physicists can calculate this effect: they tell us that the weight of a 1 g mass can vary to a maximum extent of about 0.2 μg, or 0.00002% relative. (Note: a beam balance would not be prone to this effect.) This discrepancy is many orders of magnitude too small to impinge on analytical uncertainties—analysts can safely ignore the inconstant Moon. But this trivial example points to a general problem that poses a real dilemma for analytical scientists.

Unpredictable influences

uncertainty should in fact be bigger than that, as our naïve analyst has omitted run-to-run variation – but we will see that this has no effect on our present discussion.)

Although the test itself was non-significant, the default