PREDICTION TABLE FOR RELATIVE CHAIN DIRECTIONS IN NUCLEIC ACIDS

Watson–Crick vs Hoogsteen H-bond sites	*Anti* vs *syn* glycosyl bonds	Position of base pair glycosyls *Cis*	*Trans*
		Chains are	
Same	Same	Antiparallel	Parallel
Same	Different	Parallel	Antiparallel
Different	Same	Parallel	Antiparallel
Different	Different	Antiparallel	Parallel

been made by Sundquist and Klug[4]. If the two paired bases (1) hydrogen-bond via the same sites (giving either Watson–Crick . . . Watson–Crick or Hoogsteen . . . Hoogsteen pairings) and (2) adopt the same conformation of the base with respect to the sugar (either *anti* or *syn*), then a *cis* position of the glycosyl bond leads to antiparallel chains and a *trans* position to parallel chains. Each time one of the two starting conditions is not met, a reversal in the orientation of the chains is obtained (see table). In the transfer RNA structure[3], for example, the Hoogsteen . . . Hoogsteen base pairing A9–A23 presents a *trans* position of the glycosyl bonds with *anti* conformations and a local parallel orientation of the strands, whereas the Watson–Crick . . . Hoogsteen pairing U8–A14 presents the same characteristics but with a local antiparallel orientation of the strands.

The above rules apply to the nucleotides which are pairing; additional information or assumptions are required for assessing the links between the different levels of base pairs and the chirality of the structure. They are, however, useful for generating and selecting models to test against observations from X-ray, NMR or chemical probe techniques. Further, these rules could be formalized for developing computer software able to generate automatically three-dimensional models of nucleic acids.

Because of the dyad, the fully symmetric *trans* self-pairs (for examples U . . . U or A . . . A) always have parallel chains as long as the nucleotides obey 2-fold symmetry, thus adopting the same glycosyl conformation. Pairings involving N2/N3 of guanines or N3 of adenines are excluded. A referee of this Scientific Correspondence has suggested the following compact expression of my rule: assign a parity of $+1/-1$ for (1) pairing via the same/different sites; (2) same/different glycosyl bond conformations; (3) same/different positioning of base-pair glycosyls. Then, if the product of these three parity numbers is positive, the polynucleotide chains will be antiparallel (the usual orientation) and, if the parity product is negative, the chains will be parallel.

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Scientific Correspondence
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Cometary joke

SIR — Daedalus's mechanism[1] of "exploding comets" through the condensation of solid hydrogen shows imagination but a poor knowledge of the literature. It is flawed for reasons well known to astronomers for many years.

Long-period comets from the Oort cloud making their first pass through the planetary region are seen to be anomalously bright on their inbound leg. This had previously been attributed to a 'frosting' of interstellar molecules condensed on the cold nuclei during their long residence in the Oort cloud at distances of 2×10^4 AU or more[2,3], much like Daedalus's solid hydrogen coating. But the cometary nuclei are still exposed to ultraviolet and X-ray photons in deep space[4], as well as to the intense flux of galactic cosmic rays[5]. These will act to modify the chemistry of the frosting, sputtering off the more volatile materials and creating a residue of complex refractory materials that will not sublimate so easily. Study of these mechanisms acting on ice-mantled interstellar dust grains has helped to explain the organic compounds seen in molecular cores[6] and in cometary comas[7].

Moreover, two other mechanisms work to modify and/or remove the frosting on the cometary nuclei. Impacts of interstellar dust grains result in microcratering events that appear to remove material faster than it can accumulate[8,9], thus resulting in a net erosion of cometary surfaces.

Also, heating of comets by nearby supernovae and by highly luminous young stars that occasionally pass through the Oort cloud has warmed the surfaces of all nuclei to temperatures in excess of the condensation temperature for solid hydrogen and many other volatiles[10]. The conclusion is that any solid hydrogen frosting on the nucleus cannot be expected to survive.

The anomalous brightness of new comets might still be explained by volatiles and free radicals created by cosmic-ray irradiation in the near-surface layers of the nuclei which are liberated as the comets warm for the first time on their approach to the Sun. Or it may be an outburst phenomenon resulting from the exogenic conversion of amorphous water ice formed at temperatures below 100 K to crystalline ice, which probably first occurs at about 5 AU inbound[11].

Daedalus also errs in saying that the solid hydrogen explosions explain the apparently endless supply of new comets and their random orbits. It is unlikely that the hydrogen explosions could provide sufficient impulse significantly to change the cometary orbits. In reality, the endless supply of new comets is the result of the fact that there are so many of them in the cometary reservoir, of the order of 10^{13} or more[12]. Our Sun will have left the main sequence and evolved to a white dwarf star long before the supply is exhausted.

I would hope that this is only a momentary lapse on Daedalus's part, and that his many other interesting proposals in other areas of science with which I am not so familiar are indeed as practical and as near to fruition as he suggests.

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