two groups of the selected population and have assumed a causal relationship with an exposure to dioxin. Yet the occurrence of the excess of incidence of those cancers seems not to be consistent with the level of exposure. It would be helpful to examine whether there is a correlation between the amount of dioxin absorbed (most probably in food during the first weeks after the accident), that is, the actual body burden of dioxin in individuals whose cancer has been diagnosed, and cancer incidence.

Some concentrations of dioxin in the blood of a few of those individuals have been reported by Moccarelli (*5*), and the mean values (142 to 334 parts per trillion) were higher than the background concentrations of an unexposed population. However, an analysis of the relationship between these concentrations and the cancer sites is not included in the paper.

Zober and Papke (*6*), in a study of individuals exposed in the 1953 dioxin accident at the Badische Anilin-Soda Fabrik, Ludwigshafen, Germany (four of whom died as a result of cancer), found a high concentration of dioxin either in the blood or in biopsy material 34 to 36 years after exposure. All samples (blood, adipose tissue, liver, kidney, and bone marrow) had dioxin concentrations that were 40 to 100 times higher than average background concentrations in unexposed individuals.

Similarly, Manz *et al.* (*7*) and Flesch-Janys (*8*) found a positive association between the level of dioxin exposure and cancer in a group of chemical workers with the highest exposure to dioxin, according to their location in the plant. Thus, there seems to be a correlation between the amount of dioxin absorbed and the development of cancer, as has been found in experimental animals.

Of even greater interest would be to examine the same values in children age 19 and under with leukemia or thyroid cancer in the Seveso population studied by Bertazzi *et al.* (*9*), where exposure may have lasted longer than in the adult population because of ingestion of dioxin-contaminated soil.

Studies of selected groups of individuals from the Seveso region according to their dioxin body burden [the highest found so far in humans (*10*)], would allow comparisons of tissue from patients with the same concentrations of dioxin and the possible association of health effects with a certain amount of exposure.

G. M. Reggiani
Interpharco, Ltd., Lugano, Switzerland

References

1. C. La Vecchia, F. Lucchini, E. Negri, P. Boyle, *Eur. J. Cancer* **28**, 514 (1992).
2. *Cancer Incidence in Five Continents*, vol. 6 (Scientific Publication No. 120, International Agency for Research on Cancer, Lyons, France, 1992), pp. 639–641; *Trends in Cancer Incidence and Mortality* (Scientific Publication No. 12, International Agency for Research on Cancer, Lyons, France, 1993), pp. 664–675.
3. G. M. Reggiani, in *Halogenated Biphenyls, Terphenyls, Naphtalenes, Dibenzodioxins and Related Compounds*, R. Kimbrough and A. Jensen, Eds. (Elsevier, New York, 1989), pp. 445–468.
4. P. A. Bertazzi *et al.*, *Epidemiology* **4**, 398 (1993).
5. P. Moccarelli, in *Proceedings of the Toxicology Forum*, Berlin, 9 to 11 November 1992 (Toxicology Forum, Inc., Washington, DC, 1992), pp. 238–241.
6. A. Zober and O. Papke, *Chemosphere* **27**, 413 (1993).
7. A. Manz, J. Berger, J. H. Dwyer, D. Flesch-Janys, *Lancet* **338**, 959 (1991).
8. D. Flesch-Janys, thesis, Abteilung Epidemiologie, Deutsches Krebsforschungszentrum, Heidelberg, Germany (1992).
9. P. A. Bertazzi, M. T. Laudi, A. Tironi, D. Causonni, C. Zoechetti, in *Proceedings of the 13th International Symposium on Chlorinated Dioxins and Related Compounds*, Vienna, 20 to 24 September 1993 (Federal Environmental Agency, Vienna, 1993), pp. 391–394.
10. V. Houk, in *Proceedings of Toxicology Forum on Health Effects and Safety Assessment of Dioxins and Furans*, Karlsruhe, Germany, 15 to 17 January 1990 (Toxicology Forum, Inc., Washington, DC, 1990), pp. 202–223.

■

Quantum Uncertainty Principle: No Loopholes

According to Gary Taubes' Research News article "Heisenberg's heirs exploit loopholes in his law" (11 Mar., p. 1376), the Heisenberg uncertainty principle

> holds that any measurement of a quantum mechanical system . . . will disturb the system in an unpredictable manner. The more precise the measurement, the greater the disturbance.

The stage having been set in that imprecise manner, it is then possible to say that

> researchers . . . have managed to show that the Heisenberg uncertainty principle . . . has loopholes that—with sufficient ingenuity—can be profitably exploited. The result is a series of experiments . . . to extract information from a quantum mechanical system without disturbing the variable being measured.

Finally, something more precise enters.

> To prove the concept . . . physicists will have to make a pair of measurements of the same system. The first measures the variable of interest, and the second remeasures it, showing that the variable hasn't been disturbed by the initial measurement. . . . The loophole these physicists are exploiting is the possibility of channeling all the uncertainty generated by measuring one quantum variable (a laser beam *intensity*, for example) onto a related variable, known as the conjugate observable (the beam's *phase*) [italics mine].

So says Gary Taubes.

The quantum uncertainty principle is part and parcel of the quantum degree of freedom (*1*). Such a degree of freedom is characterized by two *complementary* variables, so called because they have the same spectrum of values, and the precise measurement of one of

them precludes any knowledge of the other, in the sense that all possible outcomes occur with equal probability.

The irreducible (nonfactorable) degrees of freedom are labeled by the prime integer $\nu = 2,3,5, \ldots$, which is the multiplicity of the spectrum. Thus, $\nu = 2$ could be spin 1/2, or the basis of Fermi-Dirac statistics. The smoothed limit that produces the continuum, $\nu \to \infty$, could be the basis of the Heisenberg uncertainty principle, or of Bose-Einstein statistics.

With precise measurements of one variable, at the expense of the other, built into the system (assumed to be Heisenbergian in form), there are no grounds for handing out gold stars to celebrate "ingenuity" in the use of "loopholes." But the classical concept of conjugate variables is not the same as the quantum concept of complementary variables. In the relevant example of intensity and phase, the spectra are *not* the same. The Heisenberg uncertainty principle does *not* apply. I leave it to others to find out what does apply.

Julian Schwinger
University of California,
Los Angeles, CA 90024–1547, USA

References

1. J. Schwinger, *Proc. Natl. Acad. Sci. U.S.A.* **40**, 570 (1960); reprinted in *Quantum Kinematics and Dynamics* (Addison-Wesley, New York, 1970, 1991), pp. 63–72; *Hermann Weyl and Quantum Kinematics* (Verlag Peter Lang, New York, 1988), pp. 107–129.

History Lesson

While the Random Samples item about the death of Meriwether Lewis (6 May, p. 771) was fascinating, I think Canadians in general and historians in particular will be astounded to read that Lewis and Clark "led the first expedition across North America to the Pacific Ocean" in 1805–1806. On his first try at reaching the "Western Ocean" in 1789, Alexander Mackenzie descended the (now) Mackenzie River from Lake Athabasca to the Arctic Ocean. His second, successful expedition ascended the Peace River in 1792 to its source, crossed the Rocky Mountains, descended part of the Fraser River, and then went across country to the Pacific. According to his rock inscription, he arrived on 22 July 1793.

If we include Mexico in North America, the first white men to cross the continent on foot were Álvar Núñez Cabeza de Vaca and three other survivors of the Narváez expedition. In the years 1528–1536, they went from Tampa Bay to Apalachee Bay (Florida), built small boats and "coasted" until shipwrecked on Galveston Island (Texas), then went overland through what is now Texas, Chihuahua, and Sonora to the Pacific.

Carolyn A. Carr
342 Payne Street,
Auburn, AL 36830, USA

Corrections and Clarifications

The News & Comment article "Animal tests take back seat to clinical data" by Lisa Seachrist (10 June, p. 1525) misidentified the author of a study that found specific mutations in the tumor-suppressor gene p53 in 50% of liver tumors from rats fed tamoxifen. The work was done by Gary Williams and his colleagues at the American Health Foundation in Valhalla, New York, not by David Kupfer of the Worcester Foundation for Experimental Biology, as the article reported. Kupfer found that tamoxifen is converted to reactive metabolites in the rat liver that become covalently bound to liver proteins; however, it is not known if this is detrimental to the animal.

Table 2 (p. 1127) of the report "Rules for α-helix termination by glycine" by R. Aurora *et al.* (20 May, p. 1126) was incorrectly printed. The corrected table appears below. In the same report, the second sentence of reference 36 should not have appeared.

Residue						Structural motif
C3>C4>C2	C1	Ccap	C′	C″	C‴	
Apolar Lys or Arg	Polar or Ala		Gly	Apolar Lys or Arg	Not "bulky"†	Schellman
Polar* not Lys not Arg	Apolar* not Ala		Gly	Apolar Lys or Arg		Helix continuation
Apolar Lys or Arg preferred			Gly only	Polar not Lys not Arg		α_L

*The helix continues if C1 is apolar or if C3, C4, and C2 are all polar and interaction with C″ is not possible. †In our polyalanine model, Trp was strongly disfavored for steric reasons, although smaller aromatic residues were allowed. More realistic sequences may impose further steric constraints.