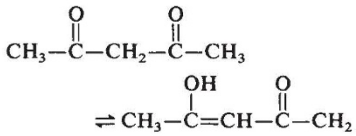
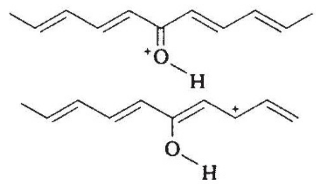
[their reaction (1)] for the copolymer. But in fact, tautomerization is an internal rearrangement as exemplified by



Wudl *et al.* propose the formation of the conjugate acid of the copolymer, which we have shown would occur on treatment with acidic methanol. The thermodynamically stable form of the conjugate acid is I below:

I

II



Resonance forms such as II or others with the charge further removed, are less stable. Neither I nor II is an enol. Therefore, the argument of Wudl *et al.* that insertion of a CO-derived moiety need not interrupt conjugation does not merit consideration.

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1. Chien, J. C. W., Babu, G. N. & Hirsch, J. A. *Nature* **314**, 723-724 (1985).
2. Chien, J. C. W. & Babu, G. N. *J. chem. Phys.* **82**, 441-456 (1985).
3. Schen, M. A., Karasz, F. E. & Chien, J. C. W. *J. Polym. Sci. Polym. Ed.* **21**, 2787-2812 (1983).
4. Chien, J. C. W. & Babu, G. N. *Macromolecules* **18**, 622-627 (1985).
5. Wnek, G. E., Chien, J. C. W., Karasz, F. E. & Lillya, C. P. *Polymer* **20**, 1441-1443 (1979).
6. Gourley, K .D., Lillya, C. P., Reynolds. J. R. & Chien, J. C. W. *Macromolecules* **17**, 1025-1033 (1984).
7. Chien, J. C. W. & Schen, M. A. *Macromolecules* (submitted).
8. Yaniger, S. I., Kletter, M. J. & MacDiarmid, H. G. *188th Am. chem. Soc. Abstr. Polym.*, 154 (**Publisher**? Philadelphia, 1984).
9. Wnek, G. E. *et al.* in *Conductive Polymers* (ed. Seymour, R. B.) 183-208 (Plenum, New York, 1981).

A quantum potential approach to the Wheeler delayed-choice experiment

ACCORDING to Bohm *et al.*[1], when a neutron is incident along SA of a neutron interferometer (Fig. 1), the wave-packet associated with the neutron splits into two wave-packets, one taking the path AEF and the other ABF, the neutron being in one of them. Although this approach satisfies the need that when a part of a wave passes along AEF, another part of the wave should pass along ABF to lead to interference at F, from the results already obtained from neutron interference experiments, it can be shown that their approach is as inadequate as the conventional approach.

Consider the case of a magnetic field H placed over a part of the path EF. If the wave-packet containing the neutron takes the path AEF, the contribution to the phase difference at F due to the field H depends on the mass m, the magnetic moment μ and the spin s of the neutron in the wave-packet. On the other hand, when the empty wave-packet takes the path AEF, to explain consistently the relative count-rates in the counters C_1 and C_2, we have to accept that the contribution of

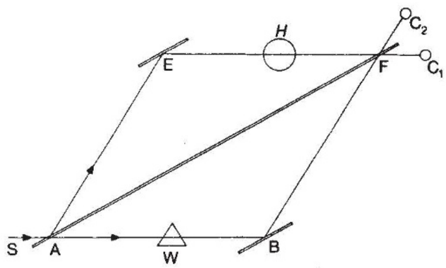

Fig. 1 Schematic arrangement of the neutron interferometer. AF, B and E are the reflecting planes, SA the direction of the incident neutrons, H a transverse magnetic field, W a material wedge and C_1 and C_2 are neutron counters.

the field H to the path difference at F is the same as before. As the neutron taking the path ABF cannot obviously be affected by the field H in the path AEF, this means that the empty wave-packet interacts with H in such a way as to lead ultimately to the same phase difference. In other words, the empty wave-packet is, in effect, not empty but has mass m, magnetic moment μ and spin s (as if it is the neutron).

Next, let us consider the case of H placed in the path EF and a material wedge W placed in the path AB. The phase shift produced by the wedge depends on the mass m and the short-range nuclear potential V of the neutron; we may regard this potential field V as moving with the neutron (just as its m, μ and s). It is well established that the experimentally observed relative count-rates of C_1 and C_2 can be attributed to the phase shifts due to H and W. There is no dispute about the way these phase shifts are estimated and related to the observed count-rates.

What has not been duly appreciated, either in the Copenhagen approach or in the quantum potential approach, is the implication of these estimates. In estimating the phase shift due to H, we accept that the mass m, the magnetic moment μ and the spin s of the incident neutron passes through H, and in estimating the phase shift caused by W we accept that the mass m and the potential field V of the same neutron passes through W. Evidently, some intrinsic property of the neutron (such as μ) cannot take one path (AEF), some other (such as V) the other path (ABF), and yet another (such as m) both paths. This is the basic enigma (or, should we say, the conceptual inconsistency) of quantum mechanics, yet to be resolved. In quantum potential approach, it is implied that in the neutron interferometer the empty wave-packet interacts with H and W as if it possesses all the properties of the neutron, without being a neutron. The enigma has assumed a new form.

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1. Bohm, D. J., Dewdney, C. & Hiley, B. H. *Nature* **315**, 294-297 (1985).

BOHM ET AL. REPLY—We feel that Umakantha has not understood our proposal. He argues that because the empty wave-packet interacts with the magnetic field it must have all the properties of the particle, that is, mass m, magnetic moment μ and spin s. Our suggestion is that the neutron is a particle that passes along one path or the other. After it has entered one of the paths, it may still be affected by the wave-packet coming from the other. Even though the wave-packet that is 'empty' is determined by Schrödinger's equation, which contains the parameters m, μ and s, the presence of these parameters in no way implies that the corresponding physical properties have passed through along with the empty packet.

To make this point still more clear, we may use the notion that the wavefunction contains something analogous to information, along the lines that we have suggested elsewhere[1]. Although the particle follows one path, its behaviour is still affected by information coming from the other path. The parameters m, μ and s appearing in Schrödinger's equation merely affect the propagation of the wavefunction and clearly do not imply that anything other than information has passed along the path not containing the particle.

An analogous case would be to have a set of computers programmed with these parameters which would correspondingly affect the behaviour of some external system. One would not want to say that, for example, mass, magnetic moment and spin were contained in the computers.

A similar discussion can be carried through for the second example of a wedge W placed in one of the paths.

In conclusion, it is in fact implied in the quantum potential approach that the 'empty wave-packet' is affected by the magnetic field, but it is clear that it does not therefore possess 'all the properties of the neutron'.

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1. Bohm, D. & Hiley B. J. *Fdn Phys.* **14**, 255-274 (1984).