Hardy Replies: In their Comment Berndl and Goldstein [1] claim that an argument due to the present author against the possibility of a Lorentz-invariant realistic interpretation of quantum theory [2] fails because the validity of the reality condition employed is questionable in the light of nonlocality. In fact, they give two reasons for this. I do now agree that nonlocality can be used to escape my previous conclusion. In this Comment I will discuss Berndl and Goldstein's two reasons and also give one more.

The sufficient condition for the existence of an element of physical reality (or "reality condition" for short) in [2] is intended to be interpreted ontologically such that if, for example, we can predict with certainty that a particle would be detected in a certain path then there is some sense in which it is true to say that it is actually in that path even if no detector is placed there to detect it. From the literature, it would seem that the term "element of physical reality" is interpreted in two different ways, either in the ontological sense intended here or simply to mean that there exist some hidden variables λ which enter into result functions and which determine the outcome of a measurement were it to be made, but without necessarily demanding any ontological significance of these hidden variables [3].

Berndl and Goldstein's first point [their (1)] has the consequence that even when the reality condition is applicable, there need not be a preexisting EPR. However, it may be that we want to assume the existence of EPR's anyway (at least when we have predictions with certainty). This situation is addressed by Berndl and Goldstein's second point (2)] (essentially the same point is made by Clifton and Niemann [4]). In [2] a run of the experiment was considered in which D^+ and D^- are measured with measurement results $D^+=1$ and $D^-=1$. On the basis of these results we obtain the EPR's $[U^+]=[U^-]=1$. As we are actually in the context of measuring D^+ and D^- it is these EPR's that must be considered real. A problem arises, however, if we require that these EPR's be interpreted ontologically because then $[U^+]=[U^-]=1$ implies that there is some sense in which we can say that the electron is in path u^- and at the same time the positron is in path u^+.

However, even given that $[U^+]$ and $[U^-]$ exist [thus avoiding Berndl and Goldstein's (1)], we find that in fact the reality condition cannot be used to infer that they must have the values $[U^+]=[U^-]=1$ when $D^+=D^-=1$. Hence, even ontologically interpreted EPR's do not have to present a problem. To see this, consider the prediction of quantum mechanics that if $D^+=1$ then $U^-=1$. Assume that we are in the context of measuring D^+ and D^- and we get $D^+=1$. Now, if we had measured U^- instead of D^- then, because of the possibility of a nonlocal influence of the choice of measurement on the $-$ side on the outcome of the result of the measurement on the $+$ side, we might then have obtained the result $D^+=0$. Thus, if in the context of measuring D^+ and D^- we get the result $D^+=1$, then it is clearly wrong to claim that we can predict with certainty that had we measured U^- we would certainly have obtained $U^-=1$ since had we measured U^- we might not have obtained $D^+=1$ (and therefore could not use the above prediction that $U^-=1$). Hence, if we have $D^+=1$ then it does not follow that $[U^-]=1$ when we are in the context of measuring D^-. This blocks the argument in [2] since it is conducted in the context of measuring D^+ and D^-. This approach does lead to one peculiarity though. When quantum mechanics is applied in the F^+ frame and there is a $D^+=1$ result, then the state of the electron becomes $|u^-\rangle$. However, if D^- rather than U^- is to be measured on the electron then it would not be correct to assert that the electron is actually in the u^- path. Associating elements of reality with eigenstates is unproblematic in nonrelativistic quantum mechanics (even taking Kochen-Specker type arguments into account) and indeed forms part of the usual interpretation [5]. It is then a rather striking conclusion that this is not possible when one goes to the relativistic case and allows consideration of a system from different frames [6].

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Lucien Hardy
Institut fur Experimentalphysik
Universitat Innsbruck
Technikerstrasse 25
A-6020 Innsbruck, Austria

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[1] K. Berndl and S. Goldstein, preceding Comment, Phys. Rev. Lett. **72**, 780 (1994).

[2] L. Hardy, Phys. Rev. Lett. **68**, 2981 (1992). See also L. Hardy, Ph.D. thesis, University of Durham, 1992; and L. Hardy, Phys. Rev. Lett. **71**, 1665 (1993).

[3] From a careful reading of Einstein, Podolsky, and Rosen's 1935 paper it would seem that they intended the ontological meaning.

[4] R. K. Clifton and P. Niemann, Phys. Lett. A **166**, 177 (1992).

[5] For example, Dirac says [in *The Principles of Quantum Mechanics* (Clarendon, Oxford, 1958), 4th ed., p. 46] "The expression that an observable 'has a particular value' for a particular state is permissible in QM in the special case when a measurement of the observable is certain to lead to the particular value, so that the state is in an eigenstate of the observable."

[6] A similar comparison with the situation in nonrelativistic QM was made by Berndl and Goldstein in a private communication.