Santini and Amoretti Reply: The preceding Comment [1] points out that our interpretation of the 17 K phase transition in URu_2Si_2 as a quadrupolar order [2] cannot account for the tiny staggered moment in terms of the customary Landau theory for a secondary order parameter (OP). We agree with this observation, which gives us the opportunity of clarifying out point of view. Our qualifying the staggered moment as a "secondary effect" could actually be misleading, since we did not mean to indicate secondary OP in the usual sense.

We share the proposal (2) of [1], i.e., that there are two phase transitions in the system. Examples of f-electron systems possessing a double quadrupolar-magnetic transition exist, such as CeB_6 ($T_Q = 3.2$ K, $T_N = 2.4$ K) [3] or UPd_3 ($T_Q = 7$ K, $T_N = 5$ K) [4], in this latter the moment being even smaller than in URu_2Si_2. A possible scenario is that URu_2Si_2 may already be on the brink of a magnetic instability above T_N. Quadrupolar order would enhance (as a secondary effect) the development of dipolar order, but not directly induce it as a secondary OP. For instance, it could affect the susceptibility at the wave vector of the magnetic state by modifying the RKKY interaction.

It must be noticed that given the tiny size of the moment, one expects macroscopic signs of the dipolar phase transition to be hard to detect. For instance, in UPt_3 no anomalies mark the transition to a tiny moment state very similar to that of URu_2Si_2. On the other hand, a direct microscopic indication of a quadrupolar order may also be difficult to obtain from elastic scattering experiments. For instance, in CeB_6 the antiferroquadrupolar state is not directly detected by neutron elastic scattering.

While we are aware that direct experimental support for this picture is lacking at present, we do not think that it is in disagreement with existing experimental findings. In particular, the staggered moment vs temperature curve $\mu(T)$, as measured in elastic scattering experiments, shows a sample-dependent prolongation above T_N which cannot be attributed to critical scattering. In contrast, the anomalies in macroscopic quantities always occur sharply at T_N, independently of the sample used. Should μ be the primary OP, or a secondary OP in the usual sense (the primary OP being some exotic time-odd quantity), the anomalies at T_N would correlate strictly with the $\mu(T)$ curve.

In summary, although the precise nature of the tiny moment state remains to be understood, we think that in view of the previous considerations, of the possibility of modeling many properties of the system, and of the fact that quadrupolar order is the most common alternative to magnetic order in f-electron systems, a quadropolar origin of the 17 K phase transition cannot be considered as unlikely.

This quadrupolar order might be detected indirectly [3] by means of neutron diffraction experiments with a strong magnetic field applied perpendicularly to the c axis.

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[1] M.B. Walker and W.J.L. Buyers, preceding Comment, Phys. Rev. Lett. **74**, 4097 (1995).
[2] P. Santini and G. Amoretti, Phys. Rev. Lett. **73**, 1027 (1994).
[3] J.M. Effantin, J. Rossat-Mignod, P. Burlet, H. Bartholin, S. Kunii, and T. Kasuya, J. Magn. Magn. Mater. **47–48**, 145 (1985).
[4] U. Steigenberger, K.A. McEwen, J.L. Martinez, and D. Fort, J. Magn. Magn. Mater. **108**, 163 (1992).

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