Svensson, Montfrooij, and de Schepper Reply: We have analyzed the roton mode [1] in ^{4}He at $p = 20$ bars close to T_λ in terms of only one damping rate $z_u/2$ and one corresponding coupling parameter f_{un}. We found that the transition from the superfluid to the normal-fluid phase is marked by a dramatic increase in z_u and by a small increase in f_{un} (reflecting the disappearance of the multiphonon component). These *continuous* changes take place predominantly just below T_λ and result in nonpropagating modes at T_λ. Glyde *et al.* [2] argue that the above mentioned observations do not signify a departure from the Glyde-Griffin (GG) interpretation (Ref. [3] in [1]) and that the softening of the roton mode caused by the increased damping is physically meaningless.

First, we stress that there was nothing in our analysis which could have forced any particular behavior to occur precisely at T_λ, as is clearly observed (see also Fig. 4 in [1]). Our analysis did not rely upon any presumed shape of the multiphonon component. Of course, all methods of analysis should give the same result above T_λ in the absence of the multiphonon component. We show the results for the roton mode at saturated vapor pressure (SVP) [3] in Fig. 1 where the results extend to within 0.0007 K of T_λ. Clearly, the behavior at SVP is similar to that at 20 bars, albeit that the roton mode does not soften completely ($z_u/2 < f_{un}$). This directly shows the physical significance of propagating vs nonpropagating modes: at SVP, the roton mode in the normal-fluid phase is propagating but strongly damped, while at 20 bars the damping has increased (due to the increased density) resulting in overdamped modes. In the GG model, regular density fluctuations (zero-sound and/or particle-hole modes) combine with a contribution arising from exciting single particles out of the condensate: above T_λ only regular density fluctuations are visible, whereas below T_λ the sharp single-particle contribution begins to grow as the condensate fraction $n_0(T)$ grows (Ref. [3] in [1]). This would result in the *coexistence* of a sharp and a broad component below T_λ, with the sharp component gradually replacing the broad component as the temperature is lowered, as illustrated in model calculations (Figs. 5 and 6 in Ref. [4]). Thus, the main issue is whether, below T_λ, the roton mode consists of *one* or *two* components (apart, of course, from the multiphonon component at high frequencies). We have shown that only *one* component is required to describe the roton mode below T_λ, both at SVP [3] and at 20 bars [1]. Therefore, our results cannot be explained using the GG model, unless of course the two components in the GG model hybridize into one (having one lifetime and excitation energy) at all temperatures and pressures, *independent* of the value of $n_0(T)$. We also show the results for the phonon and maxon excitations, obtained using identical analysis, in Fig. 1. Although these data only approach T_λ to within 0.02 K, it is clear that the rapid increase in z_u as T_λ is approached, combined with the disappearance of the multiphonon component, occurs over the entire region $q < 2$ Å^{-1}. We believe that, to be deemed successful, any interpretation of the excitations in ^{4}He must account for this similarity for all q values.

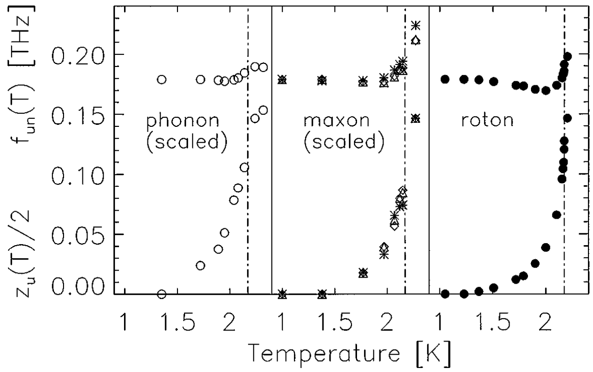

FIG. 1. f_{un} (upper part of figure) and $z_u/2$ (lower part) at SVP: $q = 0.4$ Å^{-1} [5] (open circles), $q = 0.8$ Å^{-1} [6] (stars), $q = 1.13$ Å^{-1} [6] (triangles), $q = 1.4$ Å^{-1} [6] (diamonds), and $q = 1.92$ Å^{-1} [3,5] (solid circles). For comparison, the phonon and maxon results have been scaled to the roton results [$f_{un}(T = 1\text{ K}) = 0.179$ THz and $z_u(T = T_\lambda)/2 = 0.147$ THz]. T_λ is given by the dashed lines.

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[1] E. C. Svensson, W. Montfrooij, and I. M. de Schepper, Phys. Rev. Lett. **77**, 4398 (1996).
[2] H. R. Glyde, K. H. Andersen, B. Fåk, and A. Griffin, preceding Comment, Phys. Rev. Lett. **80**, 2016 (1998).
[3] W. Montfrooij and E. C. Svensson, Czech. Phys. **46 S1**, 259 (1996).
[4] H. R. Glyde, Phys. Rev. B **45**, 7321 (1992).
[5] W. G. Stirling and H. R. Glyde, Phys. Rev. B **41**, 4224 (1990).
[6] A. D. B. Woods and E. C. Svensson, Phys. Rev. Lett. **41**, 974 (1978); (unpublished).