Rocher [29] suggested that the 39 kb transformation* in ytterbium was due to the transition of about one half of a 4f electron per atom to the valence band. He was able to correlate the data, which were available at that time, in terms of a virtual 4f bound state model with a partially occupied one electron 4f level. More recent X-ray studies of Hall and Merrill [47] and the subsequent interpretation of their atomic size data by McWhan and Jayaraman [49] have shown that ytterbium undergoes a crystal structure change, but no valence change at 39 kb. Because of this it would appear that the virtual 4f bound state model is not applicable to ytterbium at high pressures.

9. CONCLUSION

The above band models proposed for the rare earth metals are greatly simplified and it is amazing that the high temperature specific heat and Hall coefficient data give such consistent results. The biggest disappointment is that very low temperature specific heat data, except for the non-magnetic metals, do not seem to yield any reliable data concerning the band structures of these metals.

Before very high purity rare earth metals (99.99+a/o pure with respect to all impurities) become available to make direct Fermi surface measurements, there are a number of careful experiments that can be performed on these metals, which should give us some reliable data on their band structures. Low temperature elastic constant measurements on single crystals would yield an independent method for determining the Debye temperature and thus the lattice contribution to the specific heat. Specific heat measurements at very

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* Rocher used 65 kb for this transition in his paper. This larger value is taken from Bridgman [45], which was the only value available to Rocher at that time. Bridgman's transition pressure is high because (1) his ytterbium was probably not as pure as that available to later investigators [46, 47, and 48], and (2) his pressure scale was too high compared to the presently acceptable pressure scale.

low temperatures on even-even rare earth isotopes (thus eliminating nuclear contributions to the specific heat) and at very high magnetic fields of the order of 100, 000 to 1, 000, 000 gauss (which would hopefully saturate the magnetic spins and eliminate the magnetic contribution to the specific heat) would be quite informative. This latter experiment, however, might be quite difficult to achieve in the near future. Hall coefficient measurements on the remaining rare earth metals need to be made to complete the picture. Extension of Hall coefficient measurements to all the metals at high pressures would also be very interesting. Spectral studies of these metals would also be desirable to see if any other transitions similar to cerium exist. *

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* Tannhäuser [50] examined the visible light spectra of thin films of praseodymium, neodymium, samarium and erbium. He found only a broad absorption, which he concluded was due to the interaction of 4f electrons with the conduction electrons.