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TITLE MOSSBAUER EFFECT IN Eu AND EuO TO PRESSURES OF 31 GPa

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Mossbauer Effect in Eu and EuO to Pressures of 31 GPa

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We report ^{151}Eu Mossbauer Effect measurements on Eu metal in the range $4 < T < 300$ K and $P < 12.5$ GPa and on EuO for $P < 31$ GPa. Hydrostatic pressures using argon as the pressurizing medium were obtained in a simple Merrill-Bassett-type diamond anvil cell. Pressures were measured by the ruby fluorescence method. The 160-mCi $^{151}SmF_3$ source and the absorbers were held at the same temperature. The small sample size (about 8 μg) and rather large source diameter necessitated counting times of about one day per datum. Raw f-values of about 15% near 100 K reflected the efficient collimation of the 90 Ta 10 W gasket used /1/.

Eu metal orders antiferrmagnetically at about 90 K and is divalent. With pressures to 12 GPa the isomer shift changes smoothly from −7.3 to −3.8 mm s^{-1}, the saturation hyperfine field collapses from −22 to −8 T, and T_N declines slightly. The results have been interpreted as evidence for intermediate valence coexisting with antiferromagnetism /2/.

Under ambient conditions EuO orders ferromagnetically at 69 K /3/. T_C rises monotonically to about 175 K at 15 GPa /4/. Early predictions that T_C would continue to rise with pressure have been revised to suggest T_C will reach a maximum followed by a sharp decrease /5/.

At 31 GPa we find that T_C of EuO is 104(10) K, a value substantially below that found at lower intermediate pressures. The temperature dependence of the magnetic hyperfine field in EuO is shown in Fig. 1 for 0 and 31 GPa. Brillouin fits to the low temperature data show that T_C decreases for the higher pressure while the magnitude of the saturation field shows a monotonic increase with pressure. The pressure dependence of T_C is shown in Fig. 2. A maximum in T_C in the range of 16-30 GPa is implied. The (saturation) hyperfine field of ^{151}Eu in EuO at 4 K as a function of pressure is given in Fig. 3; note the monotonic change with pressure. The magnitude of the hyperfine field is often taken to be a measure of the magnetic moment. The moment should decrease at high pressure according to the theory /5/.

The isomer shift in EuO as a function of increasing and decreasing pressure along with the calculated V/V_o /6/ is given in Fig. 4. The break in slope near 13 GPa coincides with the insulator-metal transition found and a continuous valence change proposed /6/. Part of these data have been published /7/.

References

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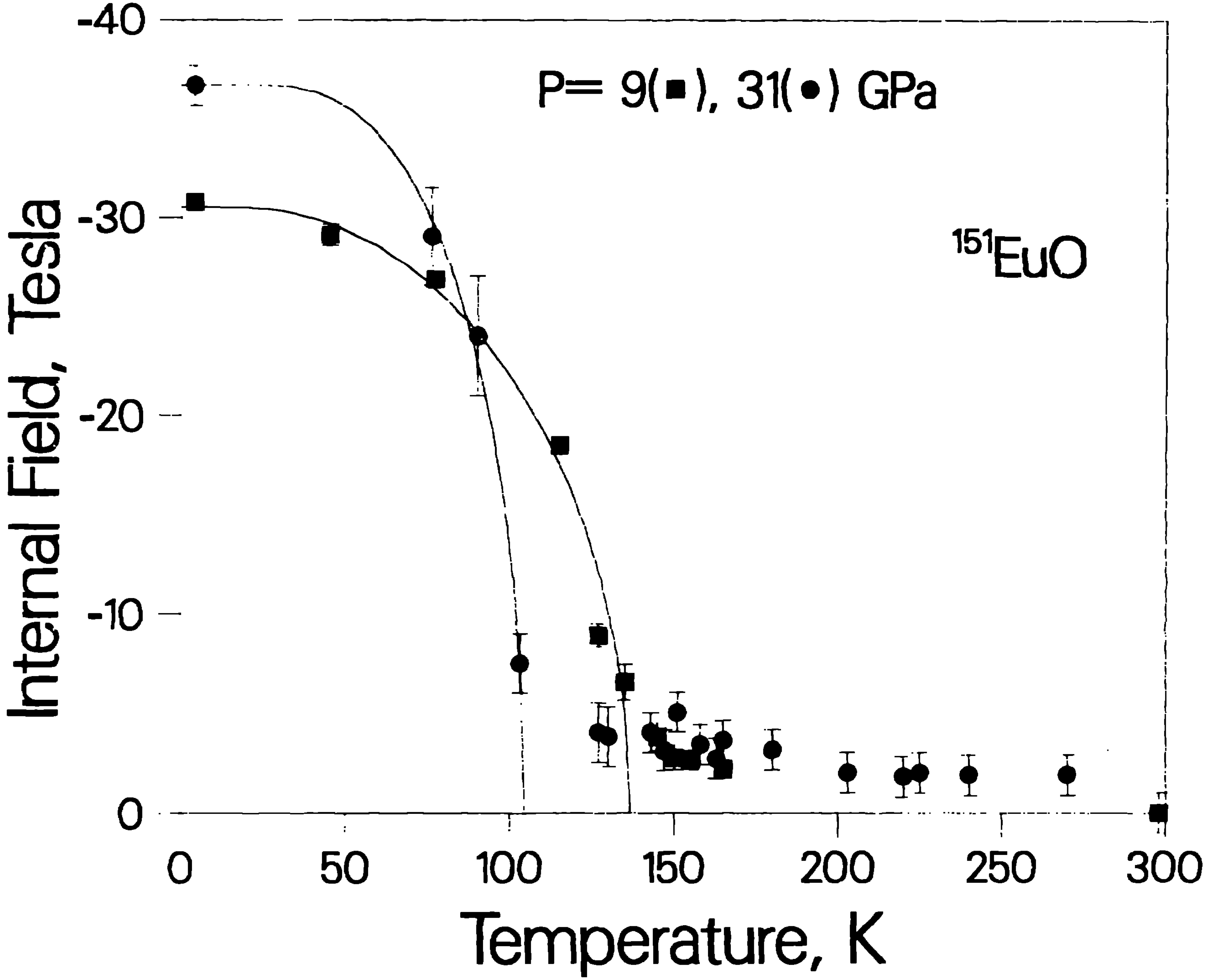
Figure Captions

Fig. 1 Internal magnetic hyperfine field as a function of temperature at two pressures.

Fig. 2 Curie temperature of EuO as function of pressure.

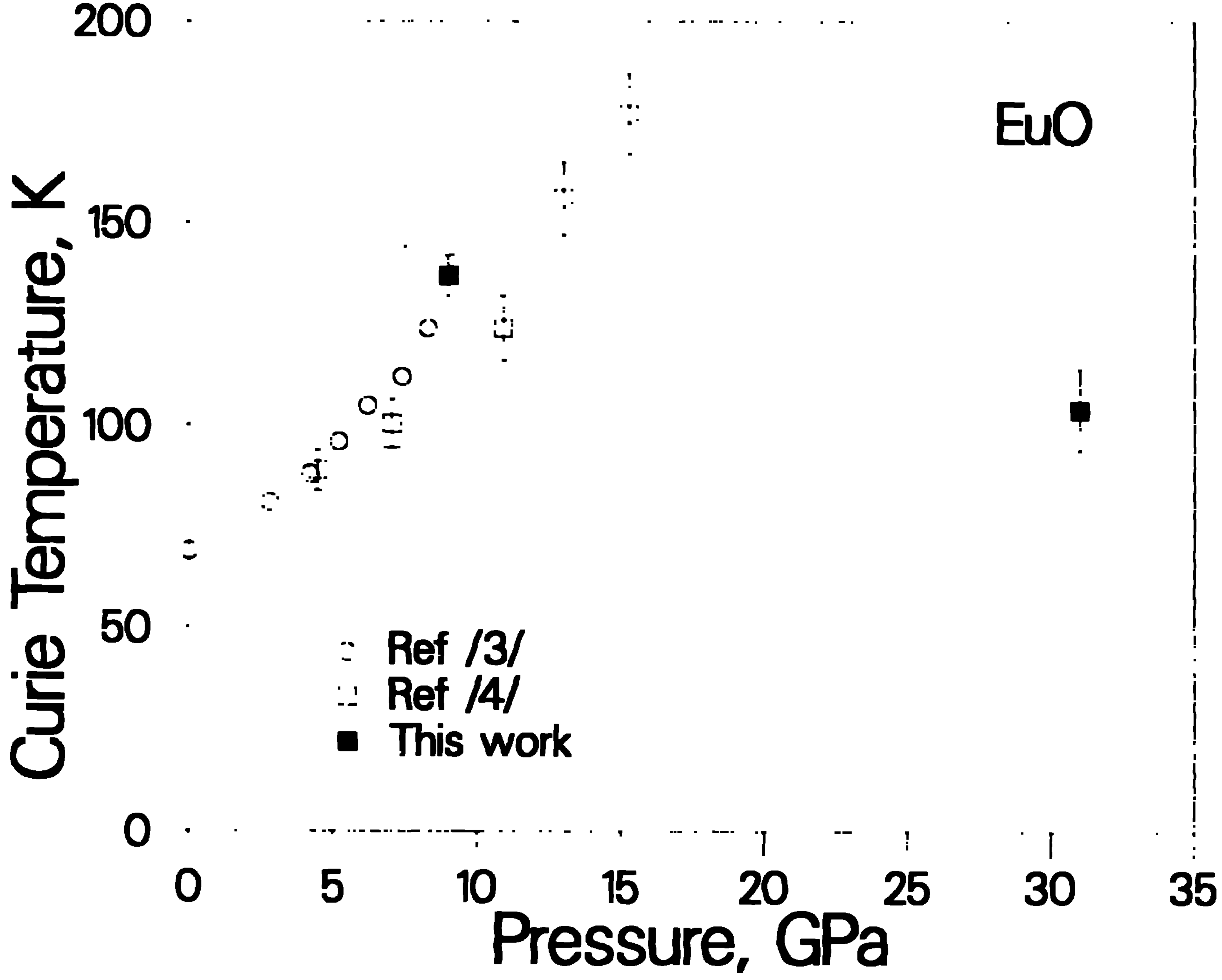
Fig. 3 Saturation magnetic hyperfine field as a function of pressure.

Fig. 4 Isomer shift of ^{151}Eu in EuO as a function of pressure and V/V_o.

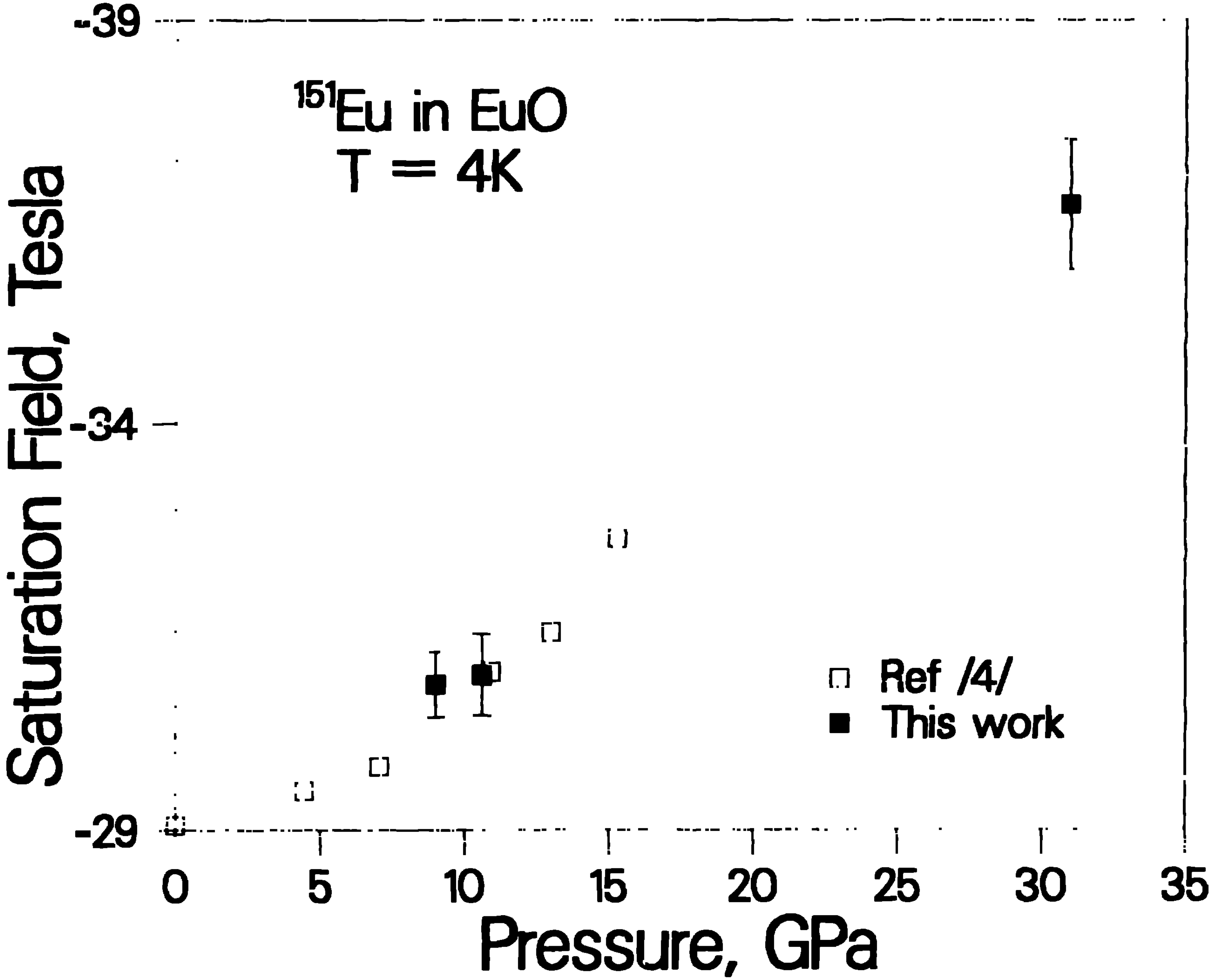


P= 9(■), 31(●) GPa
151EuO
Internal Field, Tesla
-40
-30
-20
-10
0
0
50
100
150
200
250
300
Temperature, K

1

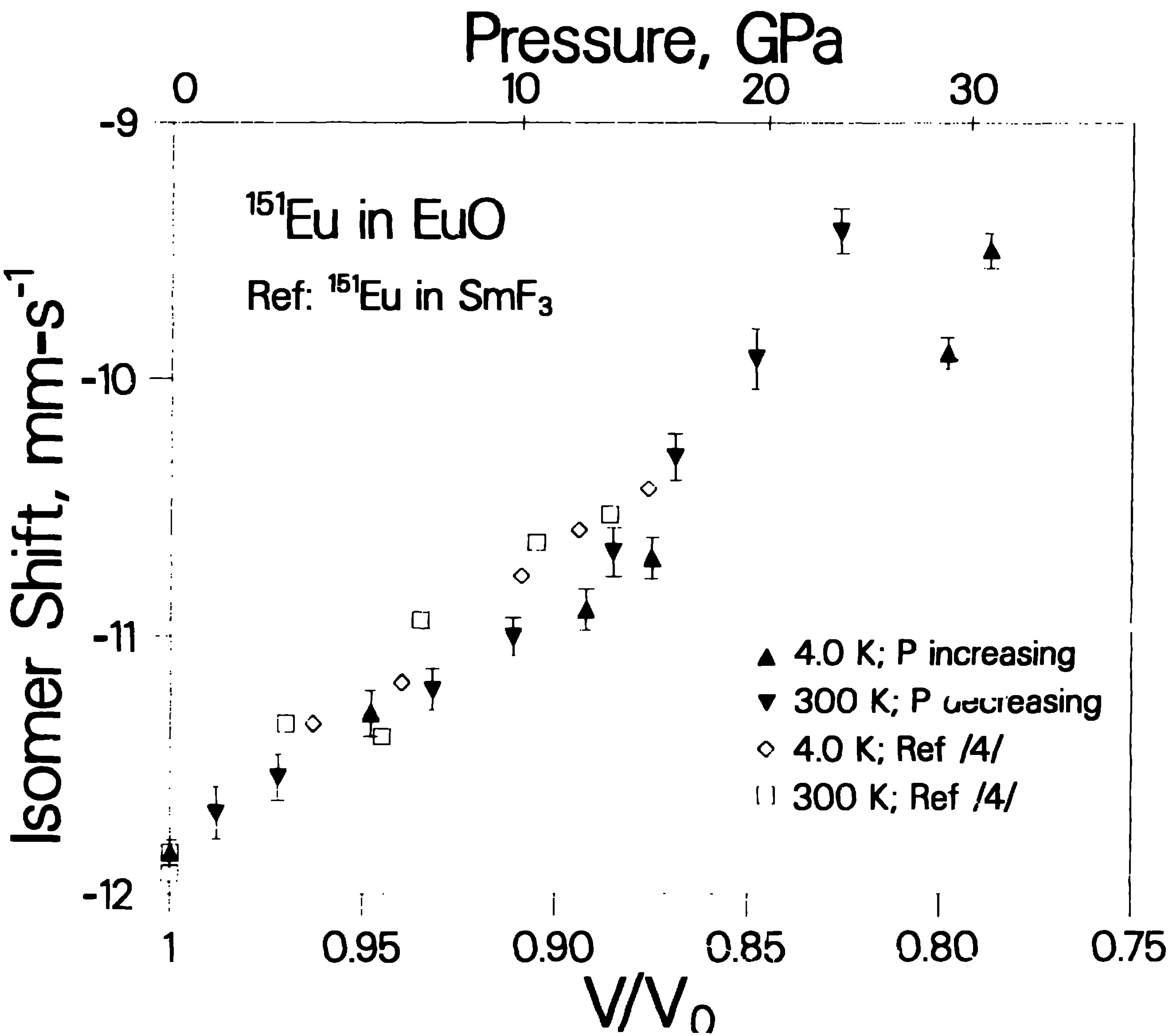


EuO
Ref /3/
Ref /4/
This work
Curie Temperature, K
Pressure, GPa
0
50
100
150
200
0
5
10
15
20
25
30
35



151Eu in EuO
T = 4K
-39
-34
-29
0
5
10
15
20
25
30
35
Saturation Field, Tesla
Pressure, GPa
Ref /4/
This work

3



Pressure, GPa
0
10
20
30
-9
-10
-11
-12
Isomer Shift, mm-s-1
151Eu in EuO
Ref: 151Eu in SmF3
4.0 K; P increasing
300 K; P decreasing
4.0 K; Ref /4/
300 K; Ref /4/
1
0.95
0.90
0.85
0.80
0.75
V/V0

4