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Authors

Fisher, R.A.
Emerson, J.P.
Caspary, R.
et al.

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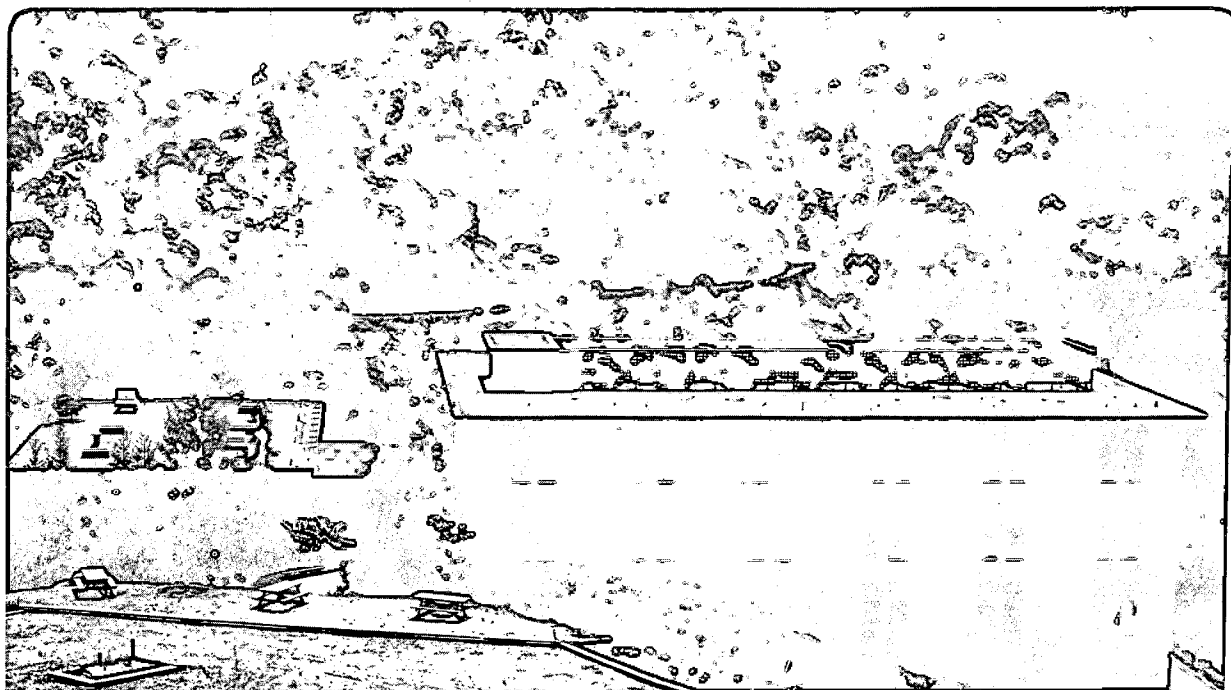
Materials Sciences Division

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The Low-Temperature Specific Heat of $CeCu_2Ge_2$ at 0 and 9.5 kbar

R.A. Fisher, J.P. Emerson, R. Caspary, N.E. Phillips, and F. Steglich

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**THE LOW-TEMPERATURE SPECIFIC HEAT OF CeCu_2Ge_2
AT 0 AND 9.5 KBAR**

by

**R. A. FISHER*, J. P. EMERSON*, R. CASPARY+,
N. E. PHILLIPS* and F. STEGLICH+**

**Department of Chemistry
Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720 USA*

*+Institut für Festkörperphysik
Technische Hochschule Darmstadt
D-6100 Darmstadt, Germany*

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The Low-Temperature Specific Heat of CeCu_2Ge_2 at 0 and 9.5 kbar

R. A. Fisher*, J. P. Emerson*, R. Caspary⁺, N. E. Phillips* and F. Steglich⁺

*Lawrence Berkeley Laboratory and (mail address) Department of Chemistry, University of California, Berkeley, CA 94720 USA

⁺Institut für Festkörperphysik, Technische Hochschule Darmstadt, D-6100 Darmstadt, Germany

CeCu_2Ge_2 orders antiferromagnetically, $T_N \sim 4\text{K}$, and $\gamma(T) \sim 200 \text{ mJ/K}^2 \text{ mole}$ near 0.5K and $P=0$. A pressure of 9.5 kbar has no measurable effect on T_N ; reduces slightly the specific-heat anomaly at T_N ; and reduces slightly $\gamma(T)$ below 0.7K. These effects of pressure are in striking contrast to the much stronger effects on other heavy-fermion compounds, e.g., CeAl_3 , URu_2Si_2 and CeCu_2Si_2 .

CeCu_2Ge_2 is isostructural with CeCu_2Si_2 , the first heavy-fermion superconductor [1]. Although CeCu_2Ge_2 is not superconducting at zero pressure (P), it is superconducting for $P > 70$ kbar [2]. Previous specific-heat (C) measurements [3] for $P=0$, $0.05 \leq T \leq 30\text{K}$, and magnetic fields (H) to 8T, showed antiferromagnetic ordering at $T_N = 4.2\text{K}$, and an anomaly in C at 0.45K and $H=0$ that was interpreted as a maximum in $\gamma(T)$. The anomaly was suppressed, but not shifted in temperature, with increasing H and disappeared at $H=8\text{T}$. This paper reports new data for C , $0.35 \leq T \leq 20\text{K}$ and $P=0$; and also data obtained at 9.5 kbar, the first for $P \neq 0$. The $P=0$ data are in excellent agreement with the earlier work [3] suggesting that the features observed are intrinsic properties and not subject to the uncertainties related to sample dependence that are associated with some heavy-fermion compounds.

In Fig. 1, C vs T , the solid line represents an estimate of the lattice specific heat (C_ℓ) obtained for $T > 14\text{K}$. The corresponding Debye temperature and γ are $\sim 240\text{K}$ and $10 \text{ mJ/K}^2 \text{ mole}$, respectively. There are substantial uncertainties in these estimates, but it is clear that C_ℓ is a negligible contribution for $T < T_N$, and γ is not large for $T > 14\text{K}$. It follows that the quasiparticles acquire high mass only at lower temperatures.

Figure 2, a plot of C/T vs T , shows the antiferromagnetic transition centered at $T_N = 4.3\text{K}$, and the anomaly. Relative to the $P=0$ data, there are small decreases in C/T just below T_N

and in the vicinity of 0.45K, but with no measurable change in T_N . The entropy (S) in Fig. 3 approaches $R \ln 2$ at higher temperatures consistent with a doublet ground state for Ce^{3+} .

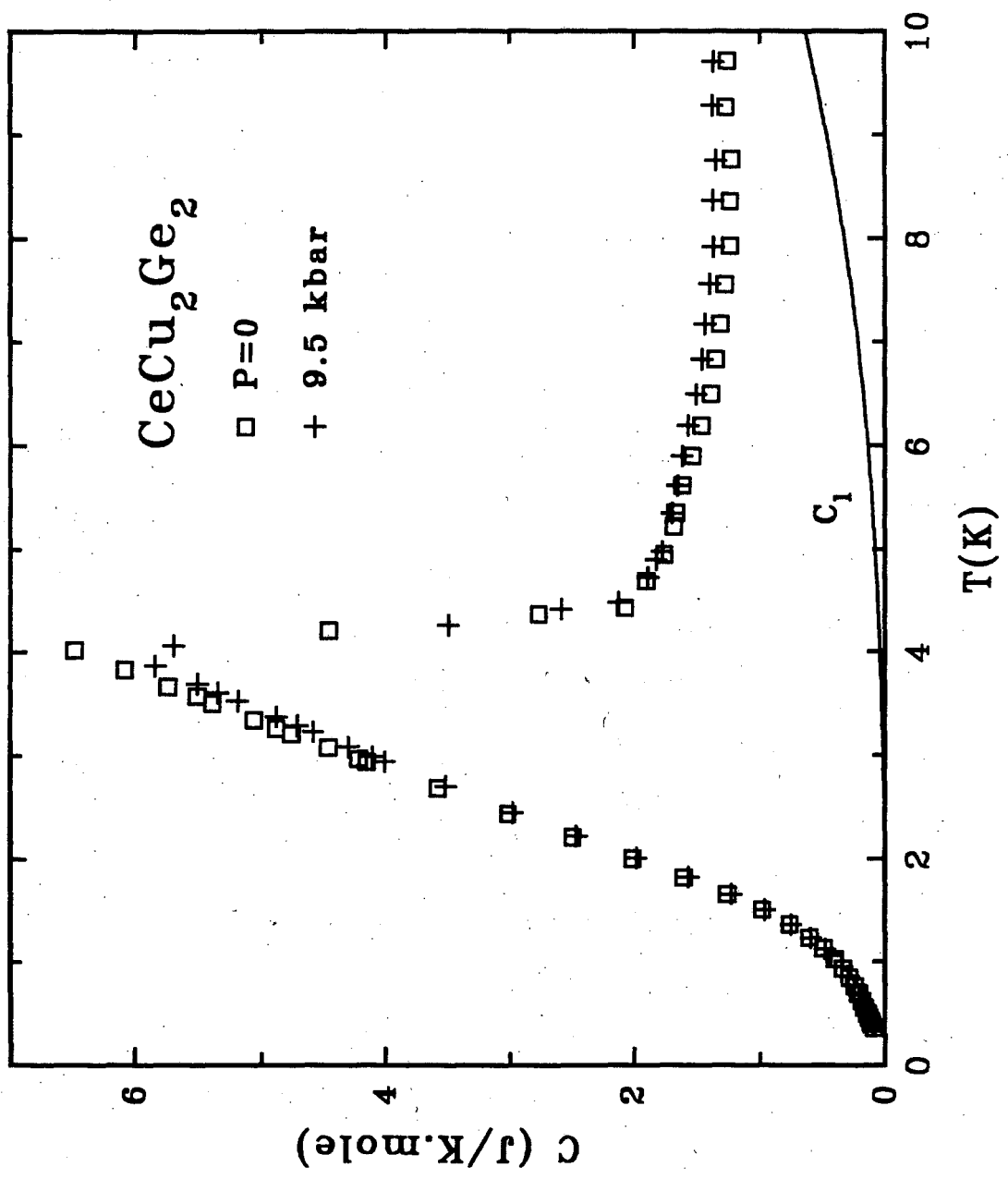
To separate the 0.45K anomaly from that associated with antiferromagnetic ordering, the procedure described in Ref. 3 was used: The low-temperature antiferromagnetic magnon contribution, $\beta_3 T^3$, was derived from a plot of C/T vs T^2 , which is linear for $0.85 \leq T \leq 1.5K$. Subtraction of that contribution, which is pressure independent, gives the "0.45K anomalies" shown in Fig. 4. Both the position and magnitude of the maximum for $P=0$ are in good agreement with those of Ref. 3. In 9.5 kbar, however, the maximum is shifted to 0.5K, and reduced in magnitude for $T < 0.7K$, by $\sim 30\%$ at 0.35K.

The weak P dependence of C near T_N is in sharp contrast to the relatively large change of C with P for, e.g., URu_2Si_2 [4] for which $T_N=18K$. $CeAl_3$ also shows a maximum in C/T near 0.4K, but it is rapidly suppressed with increasing pressure, disappearing completely for $P < 0.4kbar$, and at $P=8.2 kbar$ C/T at 0.4K is reduced to less than one third of its $P=0$ value [5]. $CeCu_2Si_2$ also shows a large change of C with P [6].

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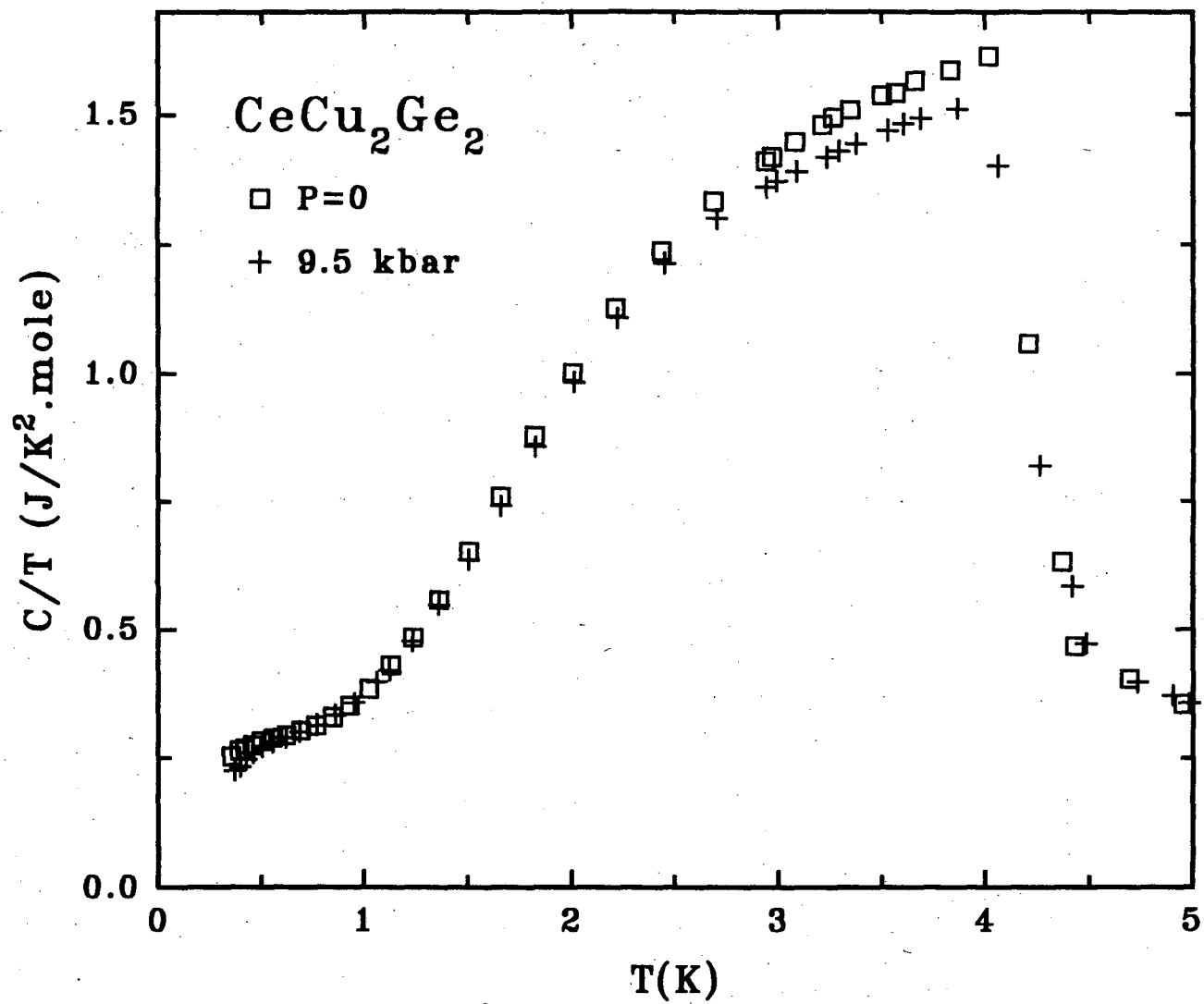
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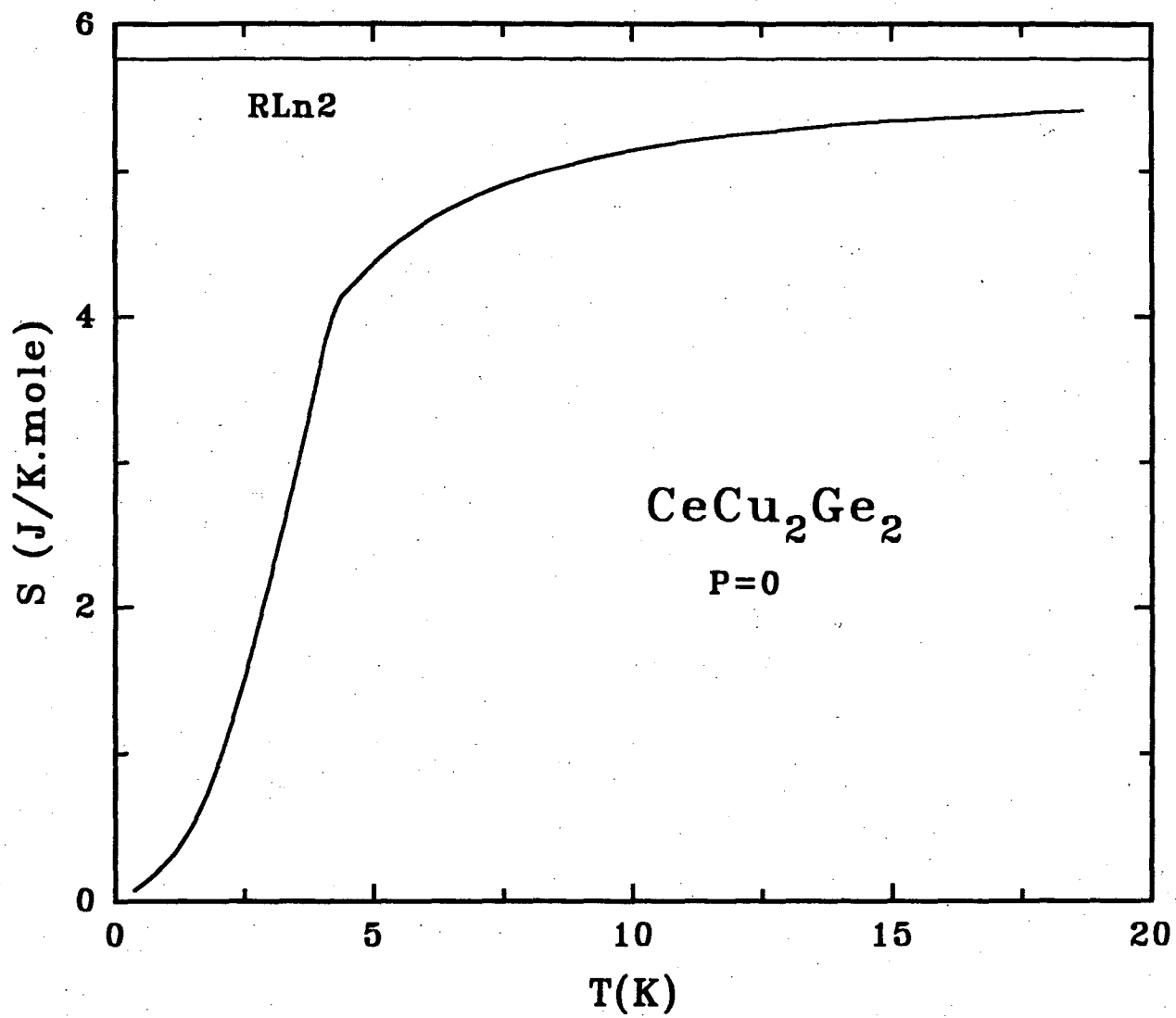
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FIGURE 1



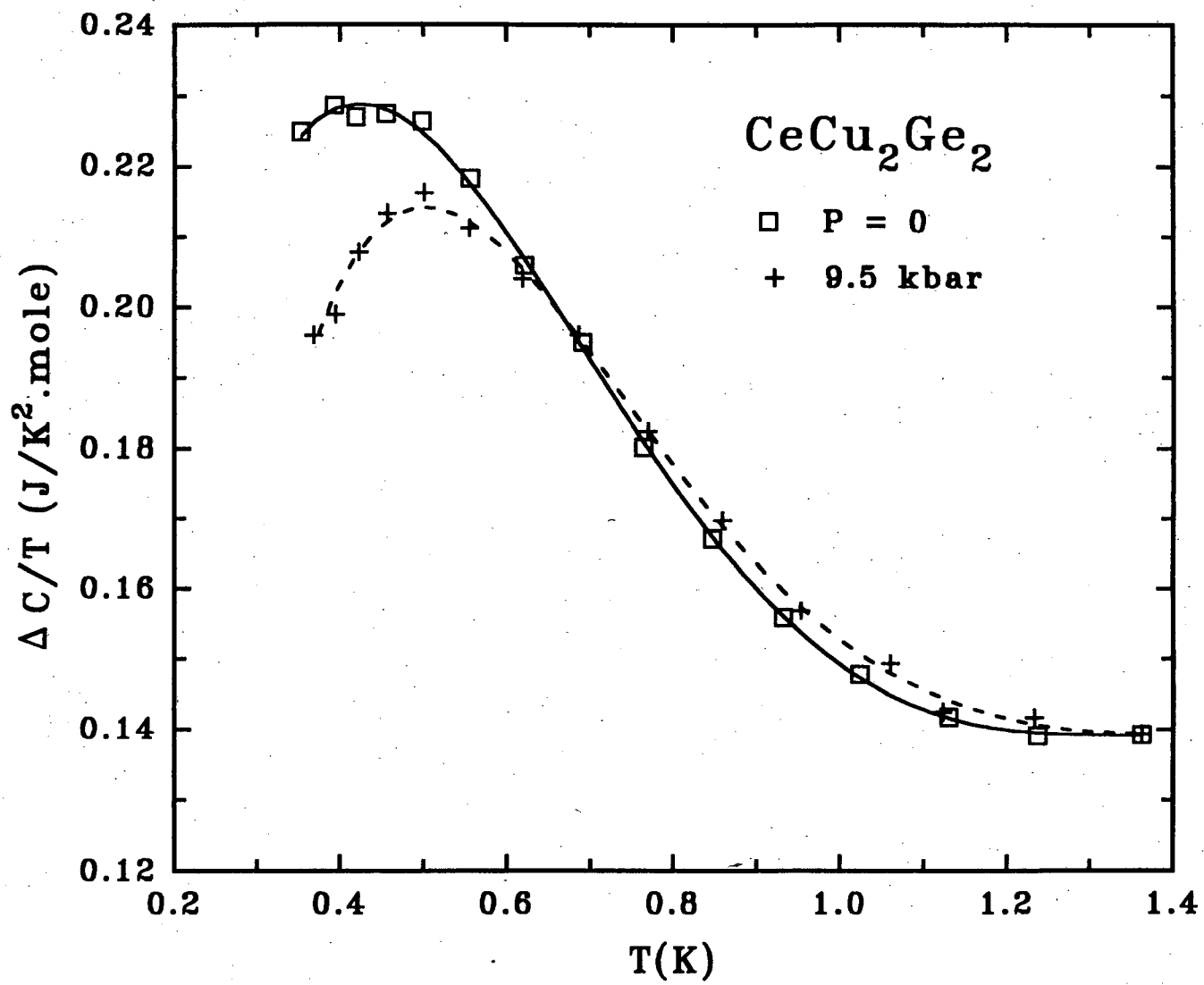
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FIGURE 2



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FIGURE 3



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FIGURE 4

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