

**[tex36] Thermodynamics of a real paramagnet**

The magnetization  $M$  of a paramagnetic system was measured over a certain temperature range, and it was found to depend only on the ratio  $H/T$ :  $M = f(H/T)$ .

- (a) Show that the internal energy is then independent of  $H$ :  $U = U(T)$ .  
(b) Show that the entropy then has the following functional form:

$$S(T, H) = S_1(T) - \frac{H}{T} f\left(\frac{H}{T}\right) + \int_0^{H/T} dx f(x), \quad \text{where } S_1(T) = S_0 + \int_{T_0}^T dT' \frac{U'(T')}{T'}.$$

**Solution:**