[tex184] Paramagnetic FD gas XI: Langevin-Brillouin limit at high $\hat{T}$.

(a) Extract, by means of systematic expansion, from the paramagnetic representation,

$$\bar{M} = \frac{1}{2}\frac{f_{\mathcal{D}/2}\big(ze^{\hat{H}/2\hat{T}}\big) - f_{\mathcal{D}/2}\big(ze^{-\hat{H}/2\hat{T}}\big)}{f_{\mathcal{D}/2}\big(ze^{\hat{H}/2\hat{T}}\big) + f_{\mathcal{D}/2}\big(ze^{-\hat{H}/2\hat{T}}\big)},$$

$$\hat{T}^{-\mathcal{D}/2} = \Gamma(\mathcal{D}/2+1)\Big[f_{\mathcal{D}/2}\big(ze^{\hat{H}/2\hat{T}}\big) + f_{\mathcal{D}/2}\big(ze^{-\hat{H}/2\hat{T}}\big)\Big],$$

of the function $\bar{M}(\hat{T},\hat{H})$ derived in [tsc16] the leading high-$\bar{T}$-term plus the leading correction to it in the form

$$\bar{M} = \frac{1}{2}\tanh\left(\frac{\bar{H}}{2\bar{T}}\right)\left[1 - \frac{1}{2}(2\bar{T})^{-\mathcal{D}/2}\mathrm{sech}^2\left(\frac{\bar{H}}{2\bar{T}}\right) + \ldots\right].$$

Begin by expanding the fugacity $z(\bar{T},\bar{H})$ for $\bar{T} \gg 1$.

Solution: