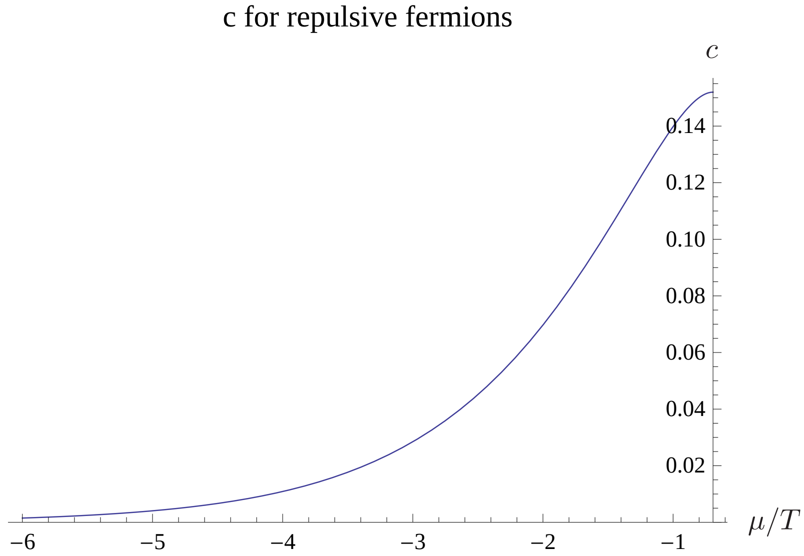

FIG. 20: The scaling function c for repulsive fermions as a function of μ/T.

The free energy density then takes the simple form:

$$\mathcal{F} = -\frac{1}{\beta} \sum_a \int (d\mathbf{k}) \left[-s_a \log\left(1 - s_a e^{-\beta\varepsilon_a}\right) - \frac{1 - y_a^{-1}}{2(e^{\beta\varepsilon_a} - s_a)} \right] \tag{106}$$

For the two-component fermion defined by the action (3), spin up particles scatter with spin down, and $G_{\uparrow\downarrow} = G_{\downarrow\uparrow}$. Thus, if the chemical potentials are equal, $\mu_\uparrow = \mu_\downarrow = \mu$, then $\varepsilon_\uparrow = \varepsilon_\downarrow$, and the thermodynamics is just two copies of the single component fermion described above. In particular, the density and c are doubled, but the energy per particle scaling functions are the same.

X. CONCLUSIONS

We have shown that the S-matrix based approach to quantum gases developed in [20] leads to a new treatment of the scale-invariant unitary limit, where all of the thermodynamic scaling functions can be computed as a function of μ/T. Though our