1 LDA results as a function of atom number

In the previous update we showed LDA results in which the trap geometry and temperature T were kept constant and the atom number was varied. We have now pushed the accessible temperatures down a little bit which allows the LDA to match our experimental data.

We show again, in Figs. 1-4, some results as a function of atom number for the coldest T accessible at each of the four values of the interaction strength relevant for comparison with the experiment.

This time we have included additional plots in the results graphic. The additional quantities that we are showing are:

n	density exclusively from QMC data (circles) is shown alongside the density from NLCE data (lines)
s	entropy per lattice site at radius r_{111}
$4\pi r^2 n$	Number of atoms in shell at r_{111} (per shell thickness)
$4\pi r^2 S_\pi$	Structure factor in shell at r_{111} (per shell thickness)
$4\pi r^2 s$	Entropy per lattice site in shell at r_{111} (per shell thickness)
s/n	entropy per particle at radius r_{111}

Keep in mind that we have trouble accessing QMC data for large radii, at the edge of the cloud, where the local value of T/t is very low. For this reason we are forced to cutoff the LDA at a certain radius. The cutoff radius is the same for the various quantities, i.e. S_π/n, s, and n (For n the cutoff is only relevant for the value of n obtained from QMC data (circles)). It can be seen that for S_π/n the cutoff radius does not pose a problem, we see S_π/n go smoothly to 1 at large radii. On the other hand the entropy per lattice site suffers an abrupt cutoff.

At the moment we care the most about $\bar{S}_\pi$ so we will ignore the cutoff issue in s. More QMC data will be required to solve this problem.

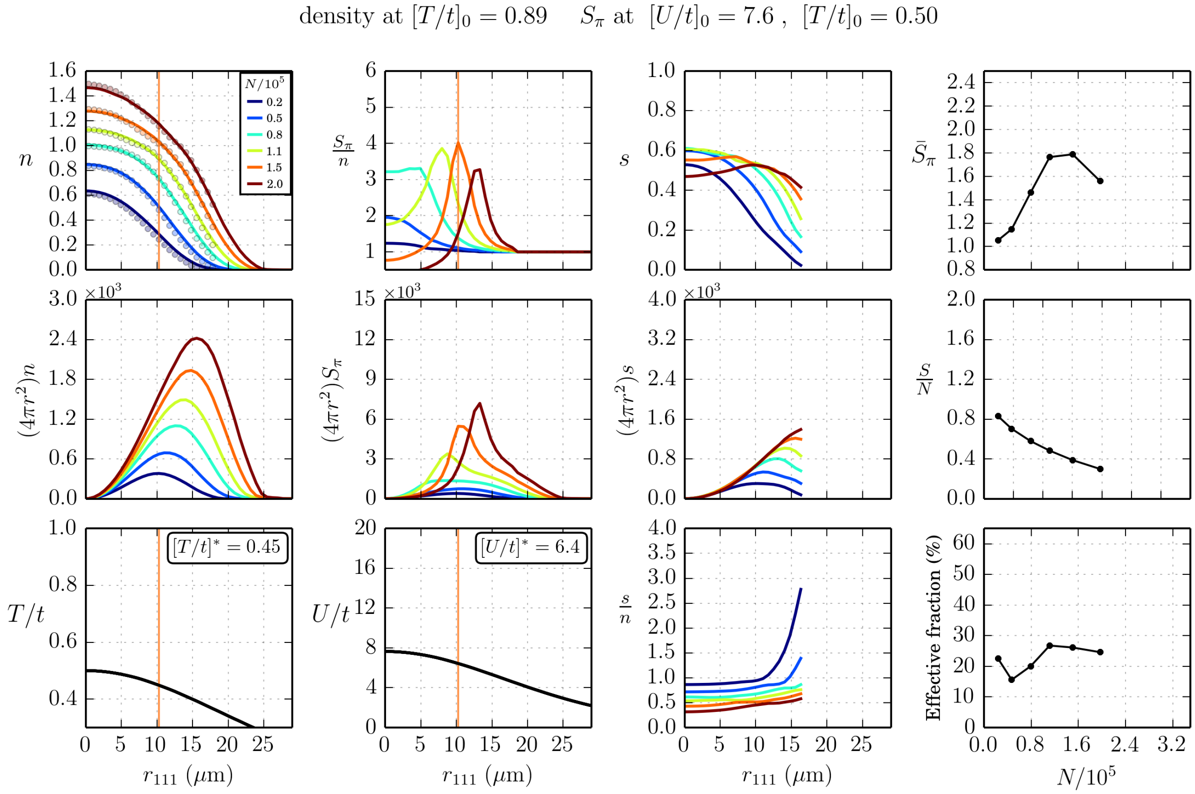

Figure 1: Scattering length $200\,a_0$ ($[U/t]_0 = 7.6$). Variation of various quantities with atom number.

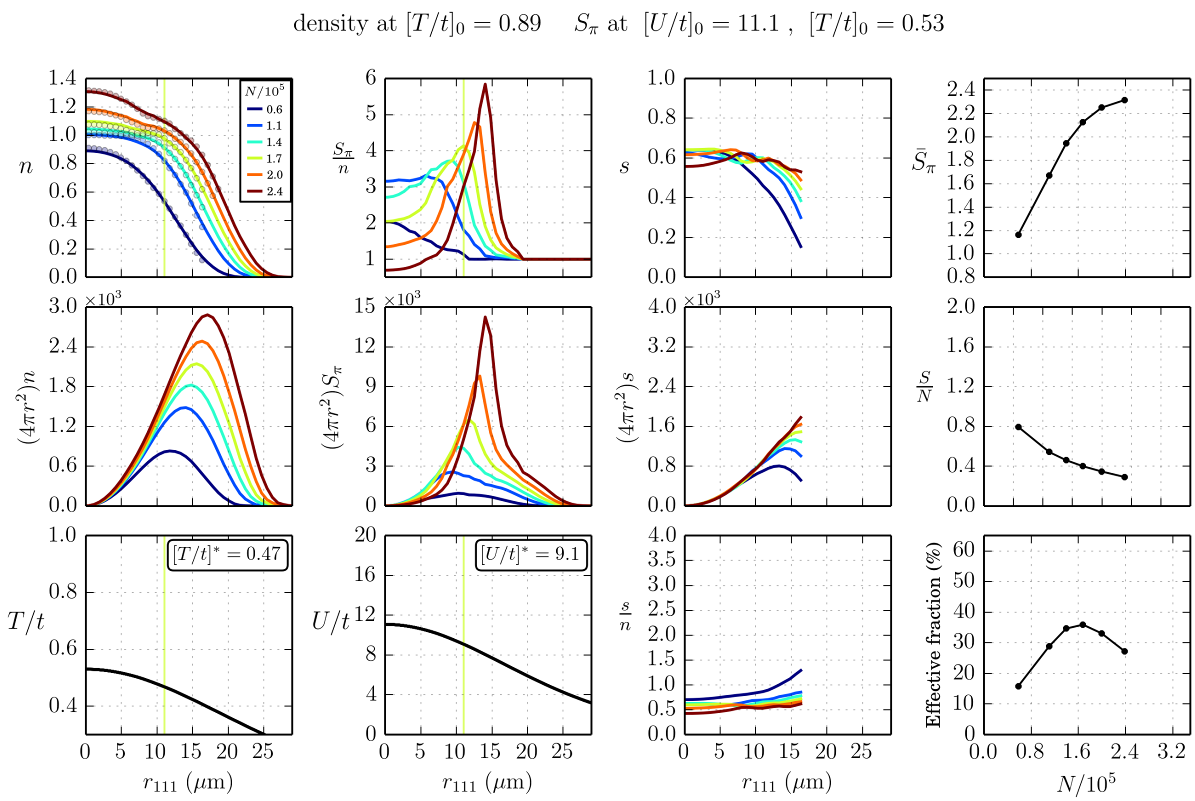

Figure 2: Scattering length $290\,a_0$ ($[U/t]_0 = 11.1$).

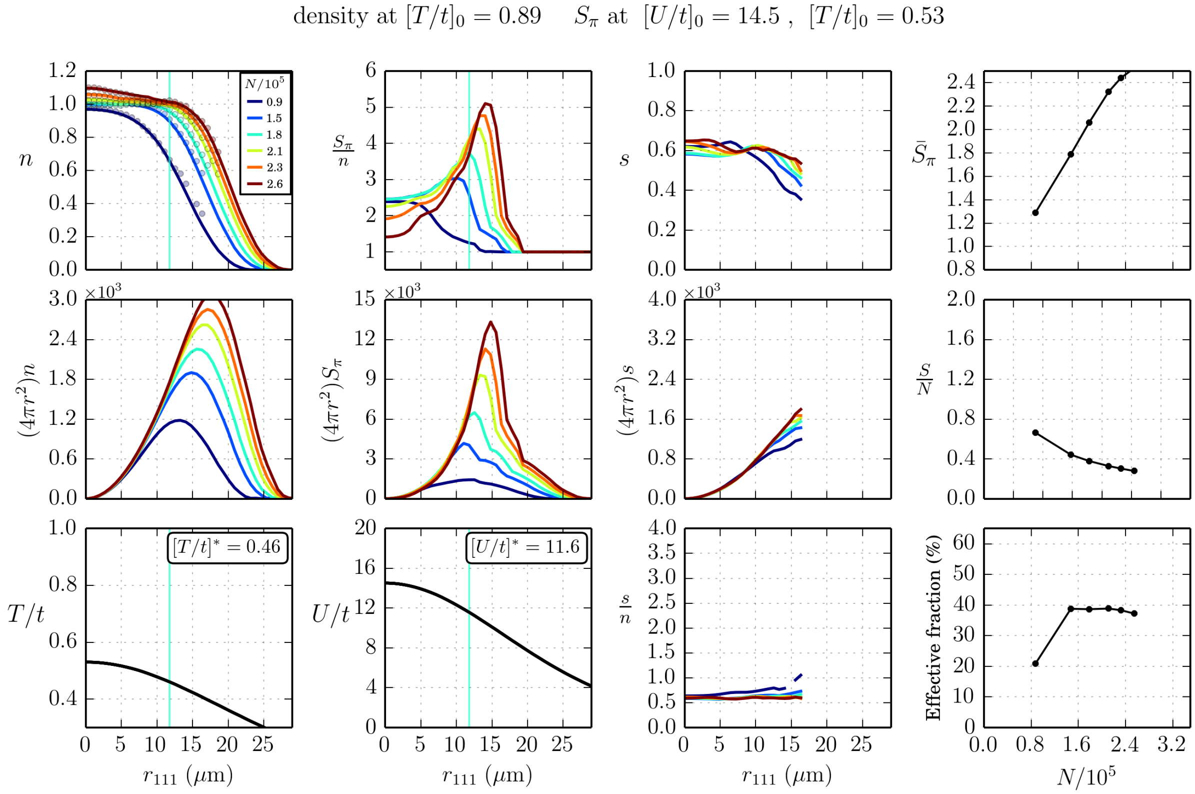

Figure 3: Scattering length $380\,a_0$ ($[U/t]_0 = 14.5$).

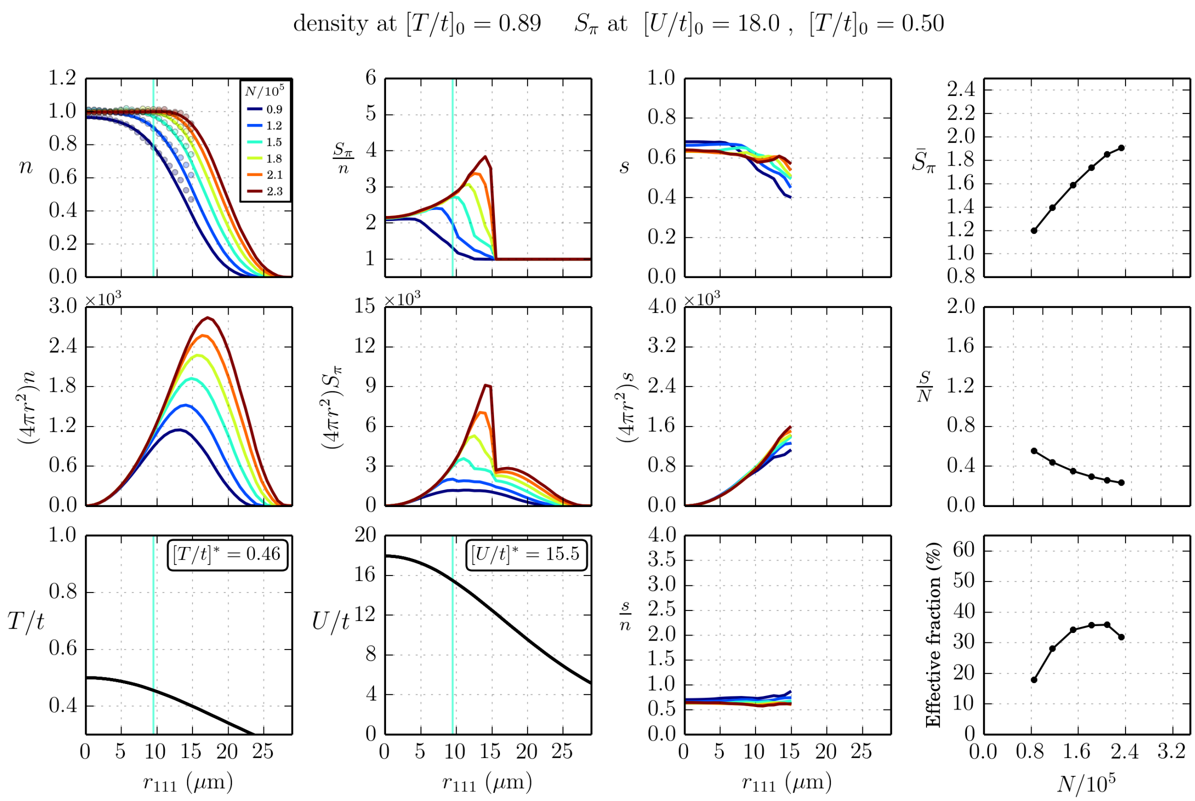

Figure 4: Scattering length $470\,a_0$ ($[U/t]_0 = 18.0$).

2 Entropy capacity of the wings

After the last report, Nandini suggested that we looked at the entropy profiles to assess the degree of entropy redistribution going on at the wings of the sample. For the LDA at the lowest T we cannot access the local entropy at the wings; so, in Figs. 5-8 we show results for a a slightly larger temperature, $[T/t]_0 = 0.68$. In that case we can sample larger radii with the QMC data and we observe the expected entropy redistribution by noticing that s/n grows quickly at large radii.

3 Comment on overall entropy per particle S/N

Looking at Figs. 5-8, in the panel that shows S/N vs N we can see that, when the atom number is varied at constant T, the overall entropy per particle S/N decreases for larger atom number.

The plot that shows $\bar{S}_\pi$ vs. N is a constant T plot, but for a better comparison with the experiment it should rather be a constant S/N plot. At the low temperatures we cannot calculate S/N properly because we do not have all of the necessary entropy data from QMC.

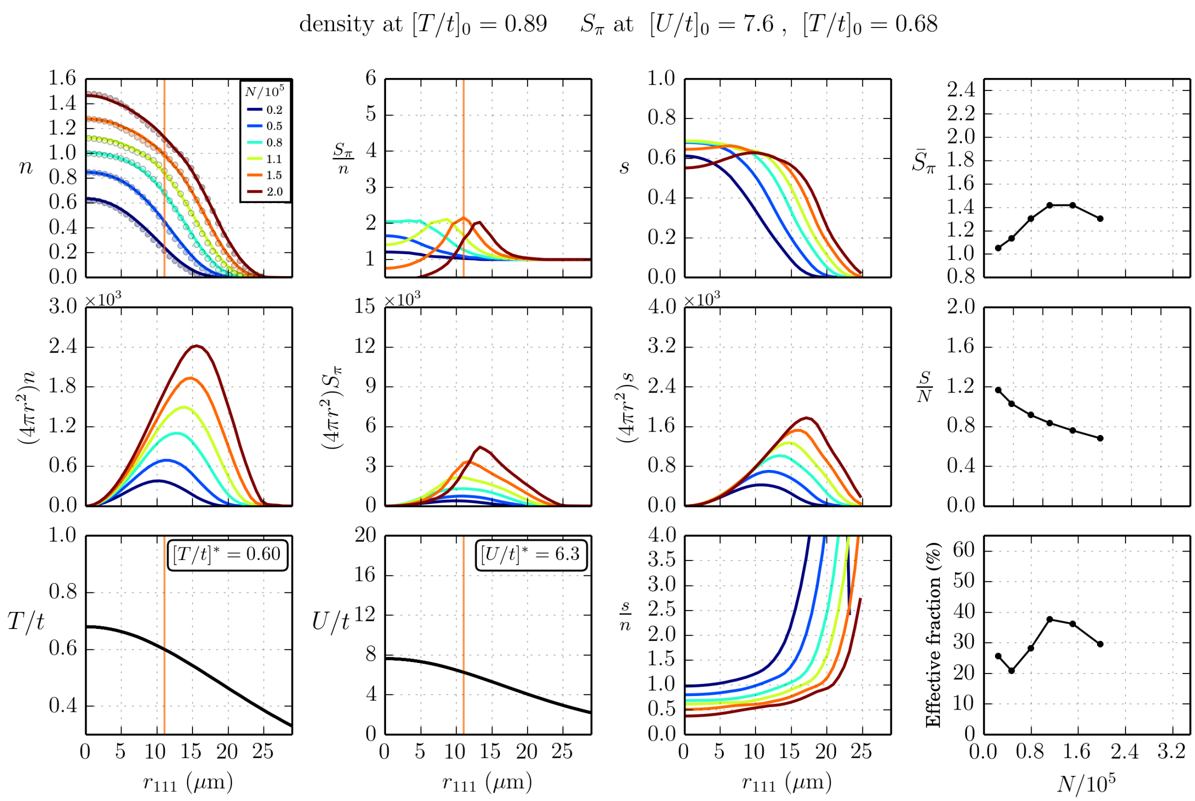

Figure 5: Scattering length $200\,a_0$ ($[U/t]_0 = 7.6$).

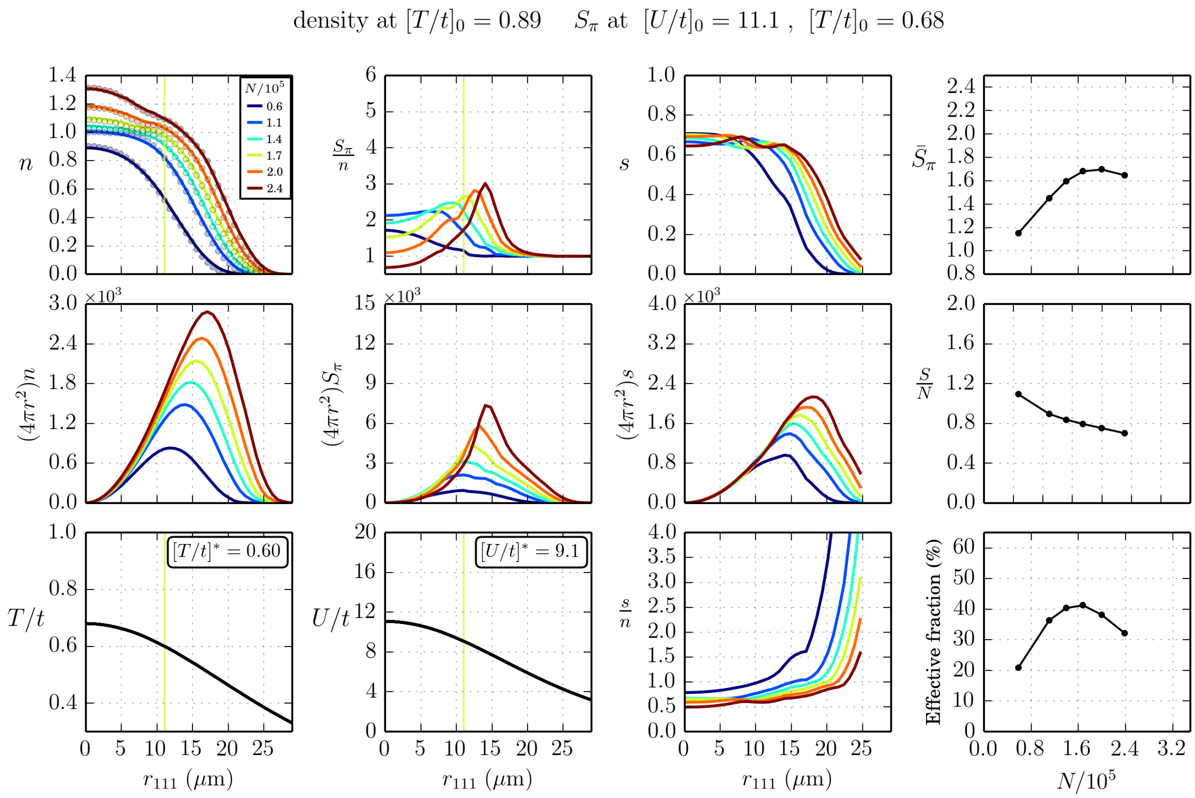

Figure 6: Scattering length $290\, a_0$ ($[U/t]_0 = 11.1$).

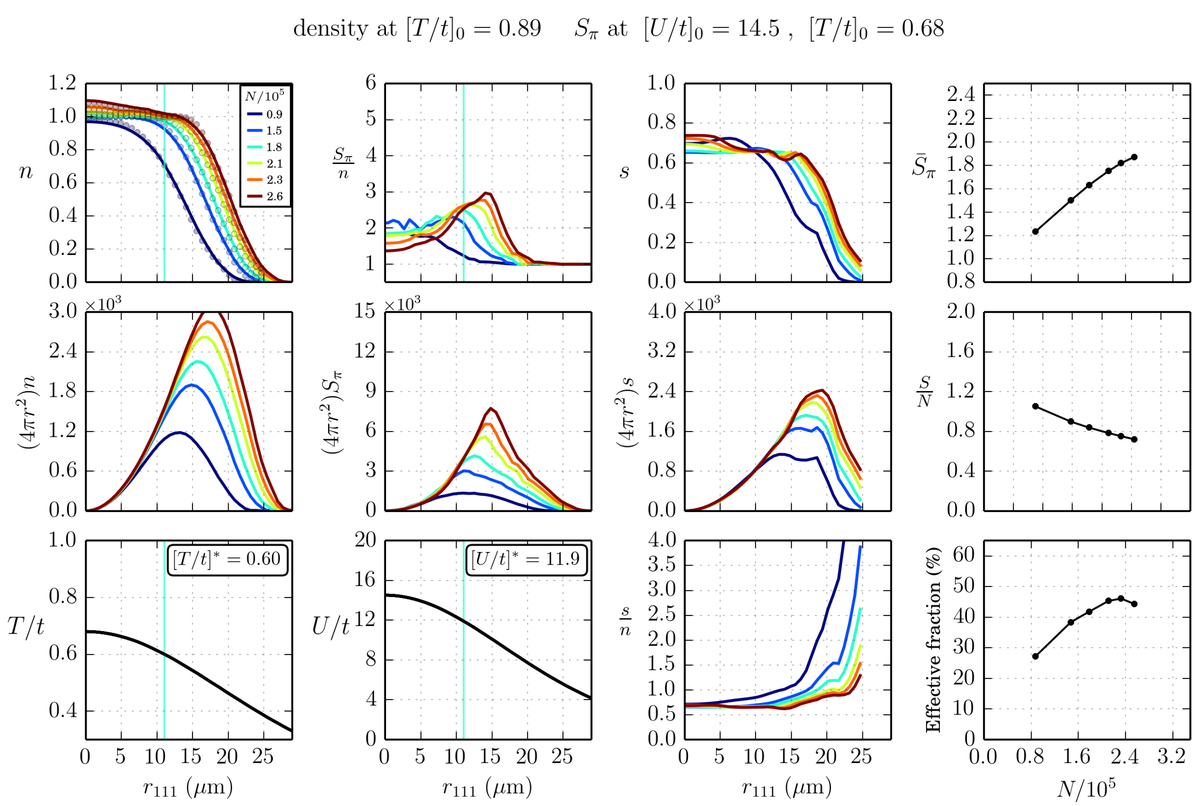

Figure 7: Scattering length $380\, a_0$ ($[U/t]_0 = 14.5$).

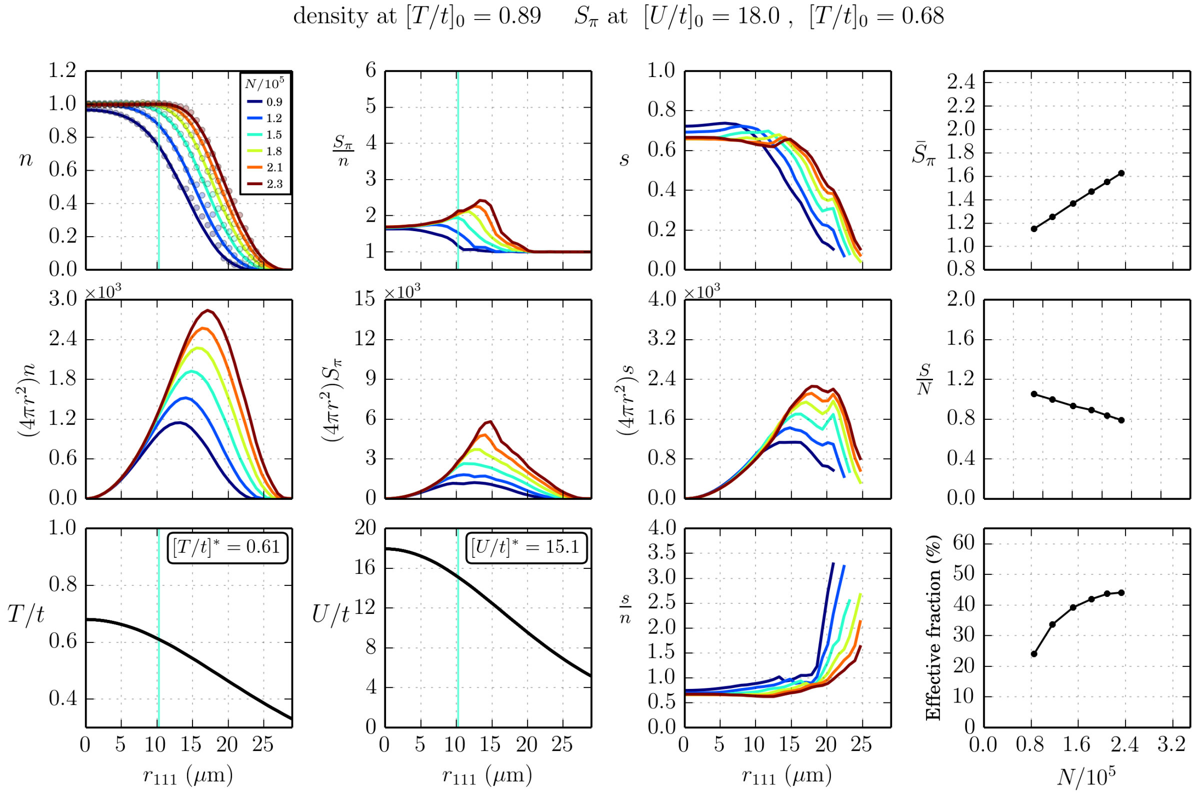

Figure 8: Scattering length $470\, a_0$ ($[U/t]_0 = 18.0$).

4 LDA results for fixed atom number

Moving beyond the atom number variation, we will focus on the LDA results that match the atom number that peaks up Bragg in the experiment. In this case we vary only the temperature and observe the behavior of $\bar{S}_\pi$ with the goal of determining the temperature at which the LDA reproduces the experimental data. The results are shown in Figs. 9-12.

For all but the largest $[U/t]_0$ we were able to reach a low enough temperature to cover the experimental data and its error bar. Notice that on the left panel the x-axis of the plot is given as $[T/t]_0$, i.e. the local value of T/t at the center of our sample. On the right panel the x-axis is given as $[T/t]^*$, the local value of T/t at the radius for which S_π is maximized. An equivalent notation is used for the local value of U/t.

Finally, if we can go ahead and find values of T_N at the relevant $[U/t]_0$ and $[U/t]^*$ we will be able to quote these temperatures in units of T_N.

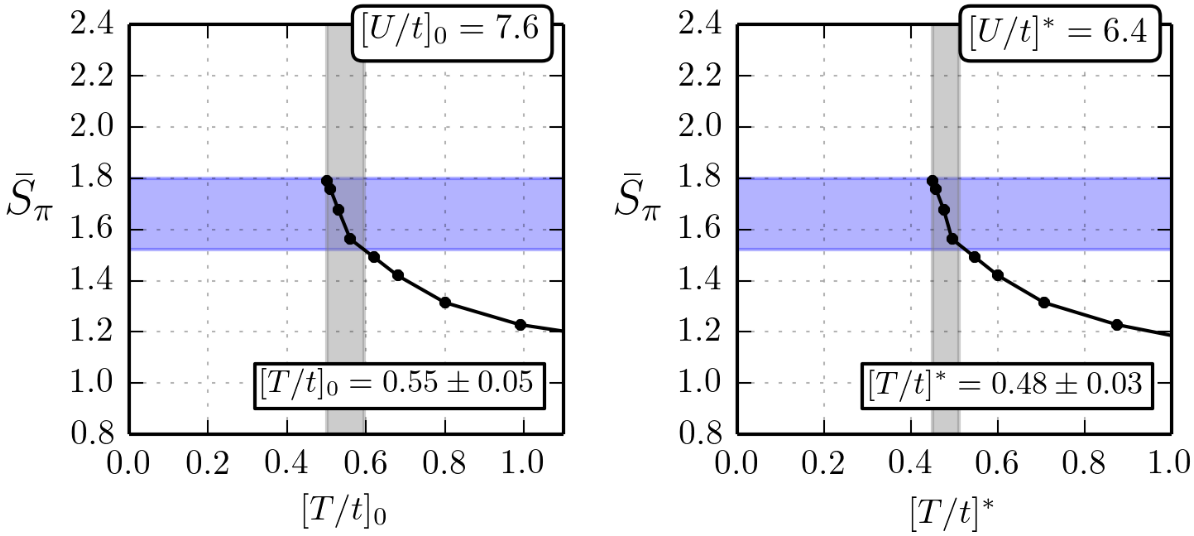

Figure 9: Scattering length $200\,a_0$ ($[U/t]_0 = 7.6$).

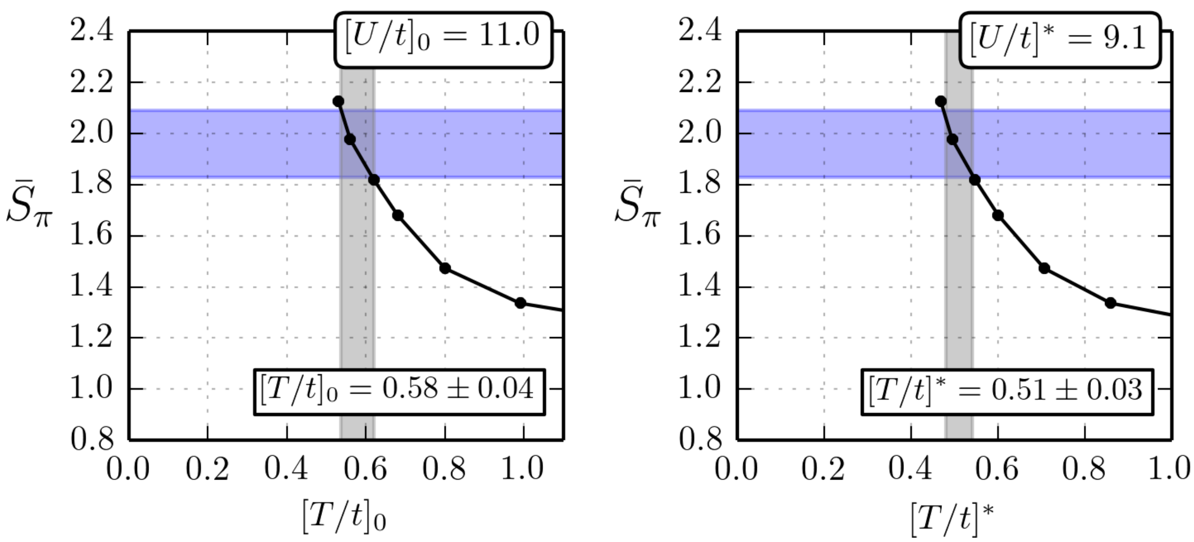

Figure 10: Scattering length $290\,a_0$ ($[U/t]_0 = 11.1$).

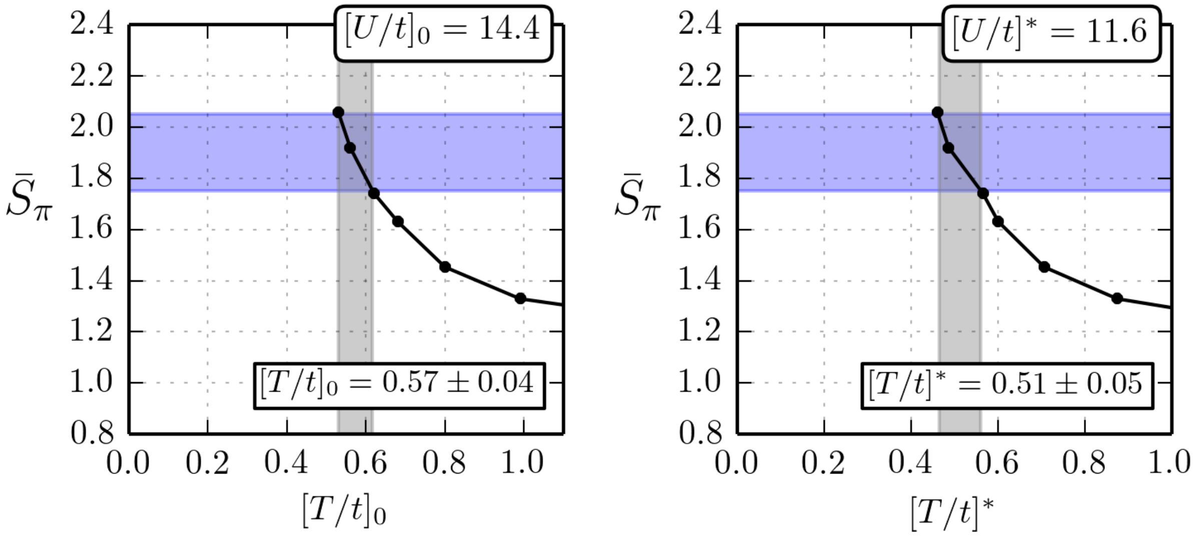

Figure 11: Scattering length $380\,a_0$ ($[U/t]_0 = 14.5$).

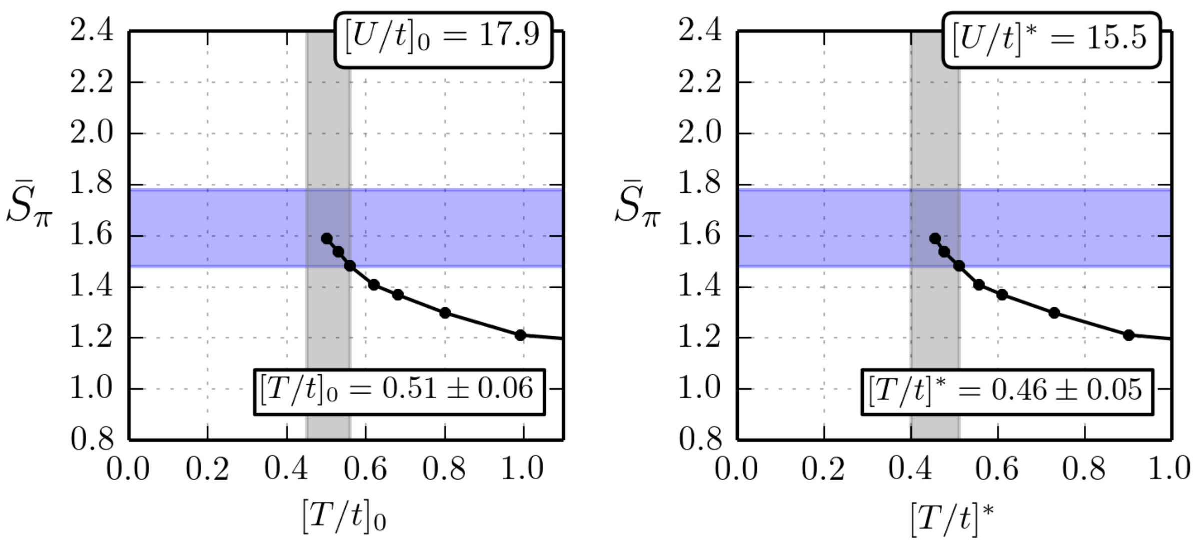

Figure 12: Scattering length $470\,a_0$ ($[U/t]_0 = 18.0$).