Exercises

1. Calculate the recoil velocity of ^{7}Li, ^{23}Na, ^{87}Rb and ^{133}Cs atoms (their respective transition wavelengths are 760 nm, 590 nm, 780 nm and 852 nm)

2. A beam of ^{133}Cs atoms travelling in the +x direction is emitted from an oven with a temperature of 200°C. A laser beam of wavelength 852 nm from –x direction is used to cool the atoms. The laser is resonant with the 6P3/2 -> 6S1/2 transition, which has a lifetime of 32 ns.

(a) What initial frequency detuning of the laser relative to the transition must be used to produce efficient laser cooling?

(b) What is the average momentum change imparted to a cesium atom during an absorption-emission cycle? What is the maximum deceleraiting force that can eb exterted on the atoms by the laser?

(c) Estimate the number of absorption-emission cycles required to cool the atoms to their minimum temperature. Estimate the time taken for the atoms to reach this temperature and the distance they would travel during the cooling process.

(d) Calculate the final temperature that the aotms reache after this experiment, on the assumption that they are cooled to the Doppler limit.

3. Calculate the Bose-Einstein condensation temperature for a gas of free ^{23}Na atoms with a density of 10^{21} m^{-3}. Estimate the de Broglie wavelength of the atoms at this temperature, and compare it to the mean partice separation.