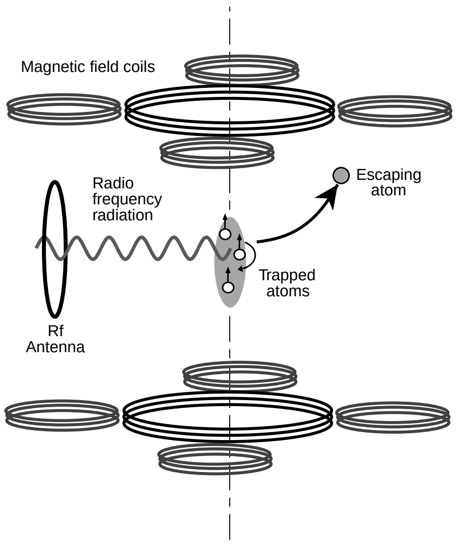
1. Cloverleaf magnetic trap

The magnetic traps used in 1995 in BEC experiments had major disadvantages or limitations: The time-dependent rotating field of the TOP trap [1], the inflexibility of a permanent magnet trap [2], the complications of having two condensates in the optically plugged trap [3], or the restrictions of a cryogenic environment necessary for superconducting coils [4, 5]. In March 1996, we achieved BEC in a novel "cloverleaf" magnetic trap [6] which overcame those limitations. This trap used dc electromagnets, had excellent optical access, and allowed independent control over the axial and radial confinement. It is a variant of the Ioffe-Pritchard trap: the coils providing the radial gradient surround the two axial coils (the so-called pinch coils) in the form of a cloverleaf. If a Ioffe-Pritchard trap is operated at very low bias field it provides tighter confinement than the TOP trap [6].



Experimental setup for cooling atoms to Bose-Einstein condensation. Sodium atoms are trapped in a cloverleaf magnetic trap. Evaporative cooling is controlled by radio-frequency radiation from an antenna. The rf selectively flips the spins of the most energetic atoms. The remaining atoms re-thermalize (at a lower temperature) by collisions among themselves. Evaporative cooling is forced by lowering the rf frequency.

In the last few years, many efforts went into the development of novel atom traps. It is somewhat surprising that, in the end, the most suitable magnetic trap for BEC turned out to be an optimization of the configuration suggested already in 1983 [7], which was used in the late 80's for trapping sodium [8] and atomic hydrogen [4, 5].

2. Study of the phase transition

We studied several equilibrium properties of Bose-Einstein condensates. By evaluating time-of-flight images, the total number of atoms, the condensed fraction N_0/N, the internal energy of the condensate, and the temperature T were determined. Below the critical temperature T_c, the condensate fraction was predicted to vary as $N_0/N=1-(T/T_c)^3$, in agreement with our results. Furthermore, we could verify that the internal energy of a Bose condensate scales with the number of condensed atoms as $N_0^{2/5}$ [6].

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