Laser Cooling Exotic Atoms

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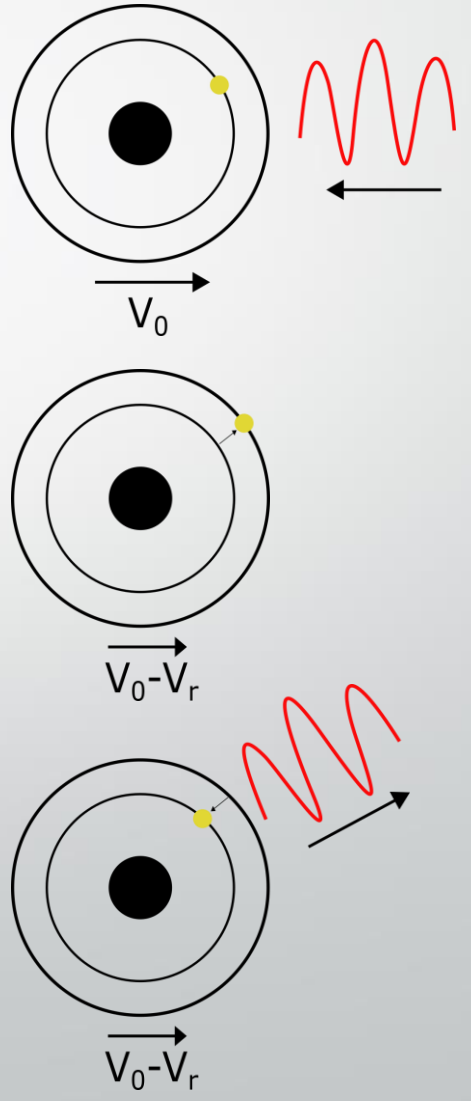
Purpose – Why Laser Cooling?

- **New science and many applications**
  - Bose-Einstein Condensate
  - Atomic Clocks
  - Atom interferometry
  - Unprecedented precision measurements of atomic structure and interactions
- **Allows new experiments**
  - Optical lattices
  - Electromagnetically induced transparency

Background – What is Laser Cooling?

- **Using photons to slow down atoms**
  - Temperature is a measure of average kinetic energy
  - Photons have momentum
  - Momentum transferred to atom when photon is absorbed
  - Photon randomly and symmetrically reemitted through spontaneous emission
  - Cycle continues until atoms are sufficiently slowed (Doppler Limit)

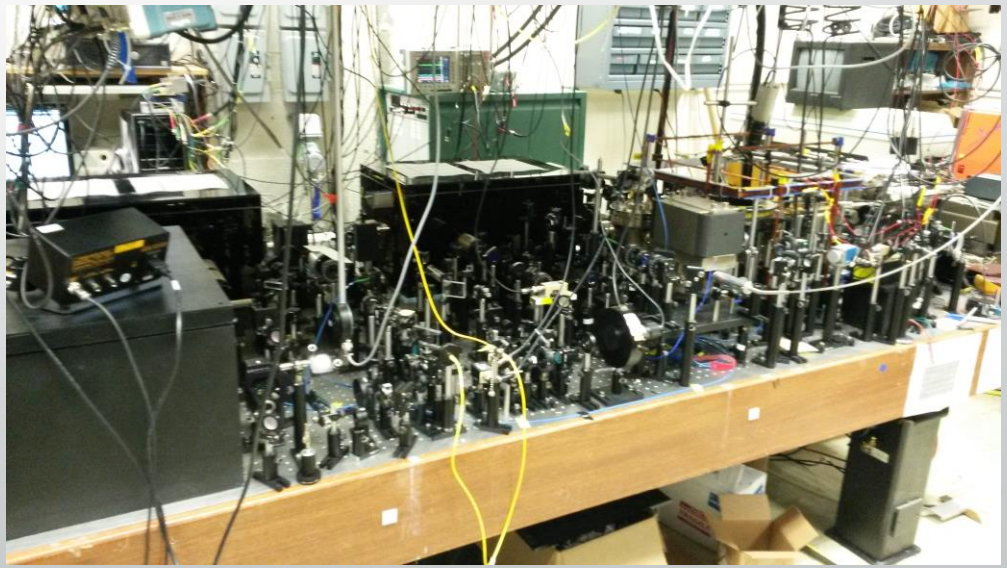


Problems with Laser Cooling

- **Cooling currently limited to select atoms**
  - Rb, Na most commonly due to simple and accessible atomic structure
- **C,N,O atoms of primary importance to biology, chemistry**
- **However, cannot be efficiently cooled with current methods**
  - Efficient laser light does not exist
  - Transition strength not sufficient/excited state lifetime too long
  - Number of lasers needed is prohibitive

Goals for the Summer

- **Research, design, simulate, and propose an experiment to laser cool one of C, N, O**
  - Abraham lab specializes in experimental AMO
  - Experimental work not possible this summer, experimental proposal work key part of experimental physics
- **Possible Cooling solutions include:**
  - 2-photon absorption
  - Pulsed frequency combs
  - Metastable excitation



Abraham lab main optics table.