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Using radio frequency radiation to discover new effects in ultracold gases

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One of the most important achievements in physics during recent years is the ability to create a Bose-Einstein Condensate (BEC) in neutral atoms. The study of BEC gives us an opportunity to discover new physics phenomena, to probe the laws of quantum mechanics and to better understand enigmatic world of small particles. A very powerful tool for these purposes is quantum simulation of interacting many-body systems.
To create BEC, very low temperatures are needed. After laser pre-cooling, Radio-frequency (RF) induced evaporative cooling is used. RF evaporation of atoms in a trap is based on coupling the trapping state to a non-trapping state with a radio-frequency field. As a result of such coupling, it is possible to control the height of the trap by changing RF frequency. With decreasing the height, the most energetic atoms will leave the trap. After thermal relaxation, when the hottest atoms are located on the top of the trap, such process can be repeated. By using evaporative cooling the coldest temperatures in the Universe could be reached.
Similar techniques can be used to modify internal atom states for implementation new spin-orbit coupling schemes that will open new possibilities to quantum simulation of strongly correlated condensed matter system. These techniques are very promising for extending spin-orbit coupling to two or more dimensions.
To modify the internal quantum states of the atoms we develop the radio and microwave frequency electronics (including control and transmission). The project will begin with the design and testing of these electronics, followed by the calibration of their effects on the ultracold quantum gases, and finally, to use these fields to create a spin-orbit coupling in the atomic quantum gas.

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