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Abstract for an Invited Paper  
for the APR20 Meeting of  
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### **Searching for Ultralight Axions with Gravitational Waves**

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I will discuss how black holes can become nature's laboratories for new ultralight particles and ongoing observations of gravitational waves can inform models of particle physics. When a particle's Compton wavelength is comparable to the horizon size of a black hole, energy and angular momentum from the black hole are converted into exponentially growing clouds of bosons, creating a gravitational atom in the sky. Theories beyond the Standard Model often include new, light, feebly interacting particles – including the QCD axion – whose discovery requires novel observations and search strategies. I will show how previously open parameter space of axions which interact only gravitationally can be constrained by observations of rapidly spinning black holes. I will also show how such 'gravitational atoms' may source up to thousands of monochromatic gravitational wave signals, with searches underway in current data, enabling LIGO to discover or exclude new particles.