Invited speaker

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Long range interacting quantum systems

Abstract

Interactions at a distance give rise to interesting quantum phenomena like blockade effects, molecular bonds [1], novel quantum phases. For neutral atoms long range interactions can be realized via their dipole moment. Dipolar interactions are fundamentally different from the usual van der Waals forces. Besides the anisotropy the dipolar interaction is nonlocal and as such allows for self organized structure formation [2]. The strongest dipoles in atomic gases can be realized and controlled in Rydberg states [3]. The corresponding interaction can lead to collective quantum critical behavior in ultracold gases [4] and is strong enough to dominate even thermal broadening in room temperature vapor cells [5]. Due to their large dipole moment Rydberg atoms in vapor cells can also be used to sense very weak microwave fields [6]. On the other hand Bose Einstein condensates can be used to sense the presence of a single electronic impurity [7].

In the future integrated optical and electronic circuits in atomic vapor cells [8] will enable applications in quantum sensing and quantum networks.

References

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About the Author

Tilman Pfau studied and received his doctorate at the University of Konstanz. After his doctorate in 1994, he lead the Atom Optics group at the institute of Prof. Mlynek. Residencies in Laboratoire Kastler Brossel (ENS) in Paris in 1995 and 1997 followed, afterwards he did research as a Feodor Lynen Fellow in 1999 for almost a year at MIT in Boston. Since 2000 Tilman Pfau is a professor at the University of Stuttgart and leads the 5th Physics Institute as a founding director. His research interests are dipolar quantum gases, strongly interacting Rydberg gases and quantum devices based on vapor cells. As an experimental physicist, he is also closely linked to interdisciplinary theorists, engineers and chemists to search for new technical applications based on quantum science.