Theoretische Physik III
- Quantenmechanik (SoSe 2019) -

Übungsblatt 12 (10 Punkte)

Ausgabe 24.06.19 – Abgabe 02.07.19 – Besprechung n.V.

Aufgaben mit Sternchen sind Klausurisomorph

▷ Aufgabe 1 (State fusion Berlin-Brandenburg) (6 Scores)

In each of the cities Berlin and Potsdam an electron was cought in a trap and prepared – in Potsdam in state ϕ, in Berlin in state χ. The Potsdamer call their electron "Fritz", the Berliner call their electron "Marlene". The inter-government commission for the fusion of the federal states of Berlin and Brandenburg the state of the tow-electron system is filed

$$|\Psi\rangle = |\phi\rangle \otimes |\chi\rangle \tag{1}$$

with the first factor the state of Fritz, the second factor the state of Marlene.

Drops in a wiseguy professor and claims the whole procedure illegal, since – after all – electrons are indistiguishable Fermions, and thus the state should be properly represented

$$|\Psi\rangle \propto |\phi\rangle \otimes |\chi\rangle - |\chi\rangle \otimes |\phi\rangle \tag{2}$$

without any mentioning of "Fritz" or "Marlene".

In view of your first-class eduction as a physicist, your are nominated a referee. The question is whether the professor is right, or one could live with the decision of the inter-governmental commission.

▷ Aufgabe 2 (Social Bosons) (4 Punkte)

Bosons are not subject to the Pauli exclusion principle. Hence it appears that Bosons are quite ordinary the every-day guys. But that is not the case. While Fermions try to avoid each other, Bosons are quite into party. Consider as an example two Bosons, each of which could occupy two orthogonal orbitals ϕ and χ. Were they distinguishable – then dubbed "Boltzones" – the two-particle system could be found in one of four states $\phi\phi$, $\phi\chi$, $\chi\phi$ or $\chi\chi$, in half of the cases in the same state. Show that, in dealing with two indistinguishable Bosons, they are found in 2/3 of the cases in the same state. Remark: As compared with their classical cousins, the *Boltzones*, the Bosons have a natural tendency to bunch. This bunching, which for massive particles becomes manifest only for very low temperatures, is responsible for many effects of low temperature physics like Bose-Einstein Condensation, Superfluidity and even Superconductivity. But even in any every-day lab of laser physics bunching is omnipresent in the behavior of Photons ...