Universität Heidelberg SS 2009

4. Präsenzübung for quantum mechanics (PTP 4)

To be jointly discussed in the tutorial on the 28.4.

Two points are given for active participation

Q P10: *3D Fourier transformation*

$$\hat{\phi}(\vec{k}) = \int_{-\infty}^{\infty} d^3x \, e^{-i\vec{k}\vec{x}} \phi(\vec{x}) \qquad \phi(\vec{x}) = \int_{-\infty}^{\infty} \frac{d^3k}{(2\pi)^3} e^{i\vec{k}\vec{x}} \hat{\phi}(\vec{k}).$$

As an example calculate the Fourier transformation of

$$\phi(\vec{x}) = \frac{e^{-\mu|\vec{x}|}}{|\vec{x}|}.$$

Q P11: *Hermite polynomials*

The Hermite polynomials $H_n(\xi)$ arise when describing the Eigenfunctions of the harmonic oscillator. Their representation comes from the following generating function:

$$Z(\xi, \lambda) = e^{-\lambda^2 + 2\lambda\xi} = \sum_n \frac{H_n(\xi)}{n!} \lambda^n.$$

(a) With help of the generating function show that:

$$H_n'(\xi) = 2n H_{n-1}(\xi).$$

(b) Use the generating function to show that $H_n(\xi)$ satisfies the following differential equation:

$$H_n''(\xi) - 2\xi H_n'(\xi) + 2n H_n(\xi) = 0.$$

(c) Show the representation:

$$H_n(\xi) = (-1)^n e^{\xi^2} \frac{d^n}{d\xi^n} e^{-\xi^2}.$$

(d) Calculate the polynomials $H_0, ..., H_3$.

Nicht einmal falsch/Not even wrong

Wenn PAULI an einem Gedanken oder einer Theorie überhaupt keinen Gefallen fand, sagte er:"Nicht einmal falsch."

Aus: Anna Ehlers, *Liebes Hertz !, Physiker und Mathematiker in Anekdoten*, Birkhäuser Verlag, 1994, S. 47