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Advanced quantum mechanics and quantum field theory, FS 2021

Blatt 8

Submission: 6.05.2021, 12:00H, **on adam in the appropriate folder.**
One file per submission please; the filename HAS TO contain your name, or the submission will not be corrected!
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(1) **Massive vector field theory** (2 Punkte)
Read and understand Example 24.4 and fill in the missing steps:

(a) Verify Eq. (24.25).

(b) Show that Eq. (24.29) solves Eq. (24.28) and discuss the role of the $+i\epsilon$ term in the denominator.

(2) **Grassmann variables** (4) Punkte)

(a) From the definition of the coherent states $|\eta\rangle$ and $\langle\bar{\zeta}|$, prove that $\langle\bar{\zeta}|\eta\rangle = \exp(\bar{\zeta}\eta)$.

(b) Find $\int \mathrm{d}\bar{\eta}\mathrm{d}\eta\, \eta\bar{\eta}$.

(c) Prove that $\int \mathrm{d}\eta\mathrm{d}\bar{\eta} \exp(\bar{\eta}\eta)|\bar{\eta}\rangle\langle\eta| = |0\rangle\langle 0| + |1\rangle\langle 1|$ and may therefore be taken as a resolution of the identity.

(d) Show that $\int \mathrm{d}^2\eta\mathrm{d}^2\bar{\eta} \exp(\bar{\boldsymbol{\eta}} A \boldsymbol{\eta}) = \det A$; here, $\bar{\boldsymbol{\eta}} = (\bar{\eta}_1, \bar{\eta}_2)$ etc., and A is a 2×2 matrix.

(3) **Lancaster/Blundell problem 24.3** (4 Punkte)

(4) **Lancaster/Blundell problem 24.4** (4 Bonus-Punkte)