

6. Physica Scripta Vol. 18, (1978), Pages 13 - 17

**Ordering of the Exponential of Quadratic Forms  
In Boson Operators and Some Applications**

A. Jannussis, **A. Streclas**, N. Patargias, D. Sourlas  
and K. Vlachos

Department of Theoretical Physics, University of Patras - Patras Greece

*Abstract*

In the present paper we find the canonical ordered form of the following general exponential function, of boson operators  $\hat{a}$  and  $\hat{a}^+$  where  $[\hat{a}, \hat{a}^+] = 1$ ,

$$\exp \{ \alpha \hat{a}^2 + \beta (\hat{a}^+)^2 + \gamma (\hat{a}^+ \hat{a} + \hat{a} \hat{a}^+) + \delta \hat{a} + \epsilon \hat{a}^+ \}$$

using parametric differentiation. With the help of the derived canonical form, we find the density matrix and the Wigner distribution function of the harmonic oscillator and the distribution function of the electromagnetic field in a simple straightforward manner.