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Non-linear ladder operators and coherent states for the 2:1 oscillator

The 2:1 two-dimensional anisotropic quantum harmonic oscillator is considered and new sets of states are defined by means of normal-ordering non-linear operators through the use of non-commutative binomial theorems as well as solving recurrence relations. The states generated are good candidates for the natural generalisation of the su(2) coherent states of the two-dimensional isotropic oscillator. The two-dimensional non-linear generalised ladder operators lead to several chains of states which are connected in a non trivial way. The uncertainty relations of the defining chain of states are calculated and it is found that they admit a resolution of the identity and the spatial distribution of the wavefunction produces Lissajous figures in correspondence with the classical 2:1 oscillator.