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PREQUANTIZATION OF THE ROTATIONAL MOTION

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Abstract. The classical problem of a free rigid body motion is considered within Kostant–Souriau prequantization programme supplemented by the semi-classical Bohr–Sommerfeld quantization rules. The results are two implicit formulae for the energy spectrum which are valid in some intervals defined by the total angular momentum.

1. Introduction

The most studied systems in classical mechanics are those consisting of "material points" and "rigid bodies". Under transition to quantum mechanics which is primarily a description of the elementary particles like electrons, nucleons and systems composed of them the first category had received much more attention than the second one. Nevertheless it is of the same direct physical importance as the first. For example, in quantizing the rotational motions of molecules they can be regarded as rigid bodies with three principal moments of inertia. When these principal moments of inertia are all equal between themselves the problem reduces to that of the spherical top. The symmetrical case when two of the principal moments of inertia are equal presents no mathematical difficulties in any quantization scheme as well, and yields simple formulae for the rotational energies in terms of the appropriate quantum numbers. The most general asymmetric case when no two of the principal moments of inertia are equal is significantly more difficult and has been treated in various quantization schemes without such definite success. That is why in the applications that involve asymmetric rotor model, the energy eigenvalue spectrum is determined numerically by diagonalizing the matrices representing the rotational energy. Another way to systemize the spectra is offered by a variety of empirical formulae which are successful in different degree when fitting the experimental