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Comment on "Proof of 'Irreducibility Postulation' and Its Applications"

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This comment points that the proof of the so-called "irreducibility postulation" is incorrect. The mistake lies in the fact that the symmetrization operator therein has no physical correspondence, and as a consequence, it provides nothing new or interesting in the concept of physics.

Key words: irreducibility, non-accidental degeneracy, accidental degeneracy.

Zou, *et al.* suggested in their recent paper [1] that the degenerate space is irreducible for the symmetry group if all the symmetries are taken into account, and thus there doesn't exist accidental degeneracy. In addition, it seems that the above result was proved in mathematics. We consider that the conclusion and proof therein are wrong.

Zou's paper began with several examples, such as the harmonic oscillator, hydrogen atom, etc., which belong to the cases of occurring higher symmetries (i.e., non-accidental degeneracy). The key for proving "irreducibility postulation" is the introduction of the operator D, which commutates with the hamiltonian H,

$$D = \begin{cases} |\varphi_{n'}\rangle\langle\varphi_n| \\ |\varphi_n\rangle\langle\varphi_{n'}| \\ |\varphi_k\rangle\langle\varphi_k| \end{cases} \text{, when } D \text{ acts on } \begin{cases} |\varphi_n\rangle \\ |\varphi_{n'}\rangle \\ |\varphi_k\rangle \end{cases}.$$

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where the $|\varphi_n\rangle$, $|\varphi_{n'}\rangle$, $|\varphi_k\rangle$ are the eigenstates of H with the eigenvalues $E_n = E_{n'} \neq E_k$, $k = 1, 2, \cdots$, but $k \neq n$ or n'. In our opinion, the above D is just a trivial symbol with no physical correspondence. That is the error in the "proof." According to the above definition of D, in the case of $E_n = E_{n'} = E_{n''} \neq E_k$, $k = 1, 2, \cdots$, but $k \neq n$, n', or n'',

$$D = \begin{cases} |\varphi_{n'}\rangle\langle\varphi_n| \text{ or } |\varphi_{n''}\rangle\langle\varphi_n| \\ |\varphi_n\rangle\langle\varphi_{n'}| \text{ or } |\varphi_{n''}\rangle\langle\varphi_{n'}| \\ |\varphi_{n'}\rangle\langle\varphi_{n''}| \text{ or } |\varphi_n\rangle\langle\varphi_{n''}| \\ |\varphi_k\rangle\langle\varphi_k| \end{cases}, \text{ when } D \text{ acts on } \begin{cases} |\varphi_n\rangle \\ |\varphi_{n'}\rangle \\ |\varphi_{n''}\rangle \\ |\varphi_k\rangle \end{cases}.$$

i.e., the definition of D (the symmetry operator in Zou's paper) is not fixed; it acts as formality only without any physical meaning. Therefore, it cannot predict anything (e.g., transition regularities) or provide a new approach to the understanding of degeneracy. In other words, the symmetry operator D does not correspond to any physical symmetry. The "proof" of the irreducibility postulation is incorrect. As for the discussion for the accidental and non-accidental degeneracy, one can refer to Ref. [2].

REFERENCES

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