

A Composite Fermion Approach to Heavy Pentaquarks

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Abstract

The ground state masses of the heavy-light pentaquark baryons like $\theta_c^0, N_c^0, \Xi_c^0$ and $\theta_b^+, N_b^+, \Xi_b^+$ for different spin states have been investigated in the frame work of diquark-diquark-antiquark configuration where the light quarks are supposed to combine to form diquarks. A composite fermion model of quasi particle has been employed to describe the diquark in an analogy of state of an electron in strong magnetic field. An electron in crystal behaves like a composite fermion absorbing a substantial amount of magnetic flux. We have suggested that the diquarks in presence chromo-magnetic field behaves like a composite fermion. Diquarks in this model behaves like an independent entity like a quasiparticle which is weakly interacting within the system. Mass has been computed in a gauge invariant way such that:

$$\frac{1}{m_D^*} = \frac{1}{m_{q_1} + m_{q_2}} \left(1 + \frac{\Lambda^4}{2p_f^4}\right) \quad (1)$$

where m_D is the mass of the diquark, m_{q_1}, m_{q_2} are the constituent masses of quark flavours, p_f is fermi momentum and Λ is a cut off parameter.

The higher states ($l > 0$) are investigated in the mass loaded flux tube model where two light diquarks are supposed to be linked by a flux tube to the heavy quark. The Regge trajectories (Total angular momentum J vs energy E) for heavy pentaquarks have been investigated. The Regge slope (α) of θ_c^0, N_c^0 and Ξ_c^0 have been obtained as $\simeq 1 \text{ GeV}^2$ which indicates that the Regge trajectory follows the linearity conditions with universal value of $\alpha (\sim 1 \text{ GeV}^2)$ where as relatively higher value of α have been observed for θ_b^+, N_b^+ and Ξ_b^+ . The results are compared with available experimental and theoretical estimates and some interesting observations are made.