Aharonov-Bohm Effect in a Semiconducting Ring With Finite Spin and Angular Momentum

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For the electrons and holes in a semiconducting ring in a magnetic field, the rotation of electrons and holes acquires a phase which affects the excitonic energy. Since, the electron is not in the same band as the hole, it does not acquire the same phase as the hole. Hence, the Aharonov-Bohm phase can become fractional. The effective charge of the electron is not equal to that of the hole due to the spin and orbital magnetic quantum-number-dependent charges so that the flux quantum depends on the inverse charge difference which becomes observable in the effective exciton energy which affects the gap. Similarly, the transmission is found to depend on the phase factor which also admits fractional flux. According to the original Aharonov-Bohm effect, the phase factor is given by $exp(ie/\hbar c)\oint A_\mu dx^\mu$ which ceases to be single valued when e is replaced by e^* due to the $j = l \pm s$ in the g value which multiplies the charge. Since, we have the $\pm$ sign in the spin, two values are generated in place of a single value. The phase factor depends on the angular momentum quantum number so that multiple values of the phase factor are generated. There is a solution for which the charge becomes zero so that $exp(ie/\hbar c)$ becomes unity.