Work Summary of the 1989 Summer Faculty Fellowship Program Performed at Goddard Space Flight Center

Choice of Gauge in 2-Photon 1s-2s Transition in Atomic Hydrogen and Pseudostate Expansions

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A number of writers have considered the problem of gauge choice in multiphoton transitions in conection with the proper choice of the unperturbed wave functions required to insure gauge invariance. In the paper, Choice of Gauge in 2-Photon Transitions: 1s-2s Transition in Hydrogen, Physical Review Letters, vol 39, #17, 24 October 1977, J Bassani, J J Forney and A Quattropani considered the case of 2-photon 1s-2s transition rate for hydrogen, using gauges $\vec{E}\cdot\vec{r}$ and $\vec{A}\cdot\vec{p}$. They obtained exactly the same results for the two gauges, but their findings indicate that the $\vec{E}\cdot\vec{r}$ interaction tends to the final result with a small number of intermediate states and is therefore the one to be used in any approximate calculation.

In our work this summer we sought to test whether the so-called pseudostate expansion method works equally well with either gauge. To accomplish this task, in addition to researching the problem, the present writer learned Fortran programming, and with the help of his NASA associates (Dr Anand Bhatia and Mrs Elva Glover) and NASA colleague (Dr Richard J Drachman) constructed a Fortran program for the calculation of the dimensionless 2-photon transition probability amplitude D(v) for 1s-2s transition in Hydrogen as a function of the incident photon frequency v in gauge $\vec{E}\cdot\vec{r}$ at certain values of v, using the pseudostate method. However, we have experienced some puzzling unresolved difficulties in our calculations. Thus, we shall continue the process upon the writer's return to his home University. Then should our pseudostate calculations prove successful for gauge $\vec{E}\cdot\vec{r}$, we shall apply the method to gauge $\vec{A}\cdot\vec{p}$. If successful, then the problem is complete.