International Journal of Theoretical Physics, Vol. 13, No. 6 (1975), pp. 417–418

A New Red Shift Mechanism with Possible Applications to Astrophysical Problems Such as Quasars

C. F. GALLO

51 Coachman Drive, Penfield, New York

Received: 10 *January* 1975

Abstract

A new red shift mechanism is proposed based on a succession of hyperfine atomic Raman interactions of a photon with hydrogen atoms. The possibility that this atomic Raman effect may be the cause of any given astronomically observed red shift can be observationally tested as follows. The hydrogen 21 cm line from the same source will *not* be shifted by this hyperfine interaction (since it is a resonance process), while visible and ultraviolet lines are shifted.

The interpretation of the cause of astronomically observed spectral line shifts play a crucial role in astrophysics. The discovery of quasars has reopened the question of the possible occurrence of red shift mechanisms other than the Doppler effect. It is suggested that a photon travelling from a source through atomic hydrogen gas may undergo a red shift through the following mechanism. The ground state of atomic hydrogen consists of an antiparallel arrangement of the electron and proton spins so that the total angular momentum (F) is zero. The parallel configuration ($F = 1$) represents a hyperfine energy state $\sim 6 \times 10^{-6}$ eV above the $F = 0$ ground state. Upon interaction with a hydrogen atom in the $F = 0$ state, a photon can lose some of its energy by exciting the hydrogen atom to the $F = 1$ state through an atomic Raman interaction. In transit, a photon may undergo a large number of energy-degrading atomic Raman interactions and a substantial red shift may ensue.

Conversely, upon interaction with a hydrogen atom in the $F = 1$ state, a photon can gain some energy by de-exciting the hydrogen atom to the $F = 0$ state through a similar atomic Raman interaction. This type of interaction yields a blue shift. In any given succession of interactions, the net shift (either towards the blue or red) depends upon the relative population of the $F = 0$ and the $F = 1$ ground states of the atomic hydrogen gas, among other things.

The possibility that this Raman interaction in atomic hydrogen may have given rise to any specific astronomical line shift can be experimentally tested by

observing the 21 cm radio line, from the same source, which arises from the spontaneous transition from the $F = 1$ to the $F = 0$ state. These 21 cm photons will *not* be shifted since the interaction with hydrogen gas will be a simple resonance process. *This is a very definitive experimental test since the visible and ultraviolet lines* (corresponding to photons with energies of several ev) *will be shifted while the 21 cm radio line will* not *be shifted.* Quasars offer conspicuous examples of specific astronomical red shift observations which might be profitably examined in the context of this suggestion, but a careful examination of all experimental observations should always be made due to the possible occurrence of this Raman interaction by a photon in transit through atomic hydrogen which is common in the universe.