

# DISTANT GALAXIES AND COSMOLOGICAL MODELS

**Edward J. Barlow** Member of National Academy of Engineering Recipient of NASA Public Service Award Previous member Report Review Committee of the National Research Council Retired Vice President, Research & Development, Varian Associates

## Model II - Very Low Mass Density Universe

Let us look at models embodying these concepts of general relativity starting with a very simple one with such low mass density that the galaxies can be treated as receding from us at constant velocities with no deceleration due to gravitational attraction. This is Model II, illustrated in [Figure II](#) which also plots proper distances away from us in billion light years against the age of the universe in billion years. The galaxy lines are still straight lines in this graph but the line showing the light packet reaching us now shows that it did indeed start near us as it has to in the big bang model and went away for a time and then started back reaching proper velocity  $c$  relative to us as it arrived. Again, the intersection of a galaxy line and the light path line gives us the time when the light was emitted that we see now and the distance away the galaxy was at that time.

In this model, we can see galaxies which are receding from us at **proper velocities** greater than the velocity of light if we define this proper velocity as the **rate of change of proper distance**. We now have two new quantities, the galaxy proper velocity when the light was emitted that we see now,  $v_e$ , and the present proper velocity,  $v_r$ . For this model, since we assumed no deceleration or acceleration of the galaxies, the two velocities are the same.

The redshift and the recession velocity divided by  $c$  are also plotted against the time  $t_e$  when the light was emitted that we see now at that redshift.

[NEXT -->](#)

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