PHY306 QUESTIONS FOR DICKE ET AL 1965

Answer all questions. Some questions may require you to consult other sources: if so, remember to reference the sources used in standard style (see the Department's web page on "Plagiarism and Collusion" for instructions on referencing). Always use your own words, unless there is justification for a brief direct quote—if there is, use quotation marks. This exercise counts 5% towards your total module mark.

1. Dicke et al. claim that two problems with the then-current model of cosmology are "the singularity characteristic of the familiar cosmological solutions of Einstein's field equations" and "the presence of matter in excess over antimatter in the universe". Briefly, and ***in your own words***, explain what they mean by this, and what possible solutions they suggest. [5]

2. What type of model are Dicke et al. (tentatively) assuming in the calculations that they report? Why do they conclude that the temperature at maximum density in this model must exceed 10^{10} K, and what is the significance of the fact that this temperature is approximately equivalent to $m_e c^2$, where m_e is the electron mass? [3]

3. Dicke et al. quote a value of 2×10^{-29} g cm^{-3} for the critical density. What value of H_0 are they assuming? Their calculation of big-bang nucleosynthesis, assuming a helium fraction of 25%, gives them a matter density of not more than 3×10^{-32} g cm^{-3}, or $\Omega = 0.0015$. Similar calculations today give $\Omega = 0.04$. The helium fraction, though only an estimate, isn't far off, so why is their number so wrong? [3]

4. If taken at face value, the above calculation for the density implies that the universe has an open geometry (in fact it's very nearly the empty de Sitter universe). Why don't Dicke et al. like this interpretation of their results? What suggestions do they put forward to "rescue" their preferred model? What is the modern solution? [4]