LAB 9

LaTeX

The goals of this lab are to learn how to produce a document in LaTeX, and to practice structured scientific writing. In order to proceed, you will need to first have a LaTeX distribution installed or use a free on-line service like Overleaf.

12.1 Symbols and equations

Below are three Nobel prize-winning excerpts from the physics literature (from Riess et al. 1998; Higgs 1964; Einstein 1905). Write up a LaTeX document that reproduces them **exactly**, including the equations.

You may choose a template or style file to work from. You will need the `amsmath` package for some of the equation formatting. Sometimes fractions and integral signs turn out unpleasantly squashed, which you can improve by prefixing the commands with `\displaystyle` (or for fractions, replace `\frac` with `\dfrac`).

To avoid typing in everything, you may want to cut and paste from the PDF document, at least for the plain-text components.

1. *High-redshift SNe Ia are observed to be dimmer than expected in an empty universe* (i.e., $\Omega_M = 0$) *with no cosmological constant.* A cosmological explanation for this observation is that a positive vacuum energy density accelerates the expansion. Mass density in the universe exacerbates this problem, requiring even more vacuum energy. For a universe with $\Omega_M = 0.2$, the MLCS and template-fitting distances to the well-observed SNe are 0.25 and 0.28 mag farther on average than the prediction from $\Omega_\Lambda = 0$. The average MLCS and template-fitting distances are still 0.18 and 0.23 mag farther than required for a 68.3%$(1\,\sigma)$ consistency for a universe with $\Omega_M = 0.2$ and without a cosmological constant.

2. The simplest theory which exhibits this behavior is a gauge-invariant version of a model used by Goldstone himself: Two real[1] scalar fields φ_1, φ_2 and a real vector field A_μ interact through the Lagrangian density

$$L = -\frac{1}{2}\left(\nabla\varphi_1\right)^2 - \frac{1}{2}\left(\nabla\varphi_2\right)^2 - V\left(\varphi_1^2 + \varphi_2^2\right) - \frac{1}{4}F_{\mu\nu}F^{\mu\nu}, \tag{12.1}$$

where

$$\begin{aligned} \nabla_\mu\varphi_1 &= \partial_\mu\varphi_1 - eA_\mu\varphi_2\,, \\ \nabla_\mu\varphi_2 &= \partial_\mu\varphi_2 + eA_\mu\varphi_1\,, \\ F_{\mu\nu} &= \partial_\mu A_\nu - \partial_\nu A_\mu\,, \end{aligned}$$

e is a dimensionless coupling constant, and the metric is taken as $-+++$.

3. Letztere ist $\frac{3}{2}(R/N)T$, während man für die mittlere Größe des Energiequantums unter Zugrundelegung der Wienschen Formel erhält:

$$\frac{\displaystyle\int_0^\infty \alpha\nu^3 e^{-\dfrac{\beta\nu}{T}}\, d\nu}{\displaystyle\int_0^\infty \frac{N}{R\beta\nu}\alpha\nu^3 e^{-\dfrac{\beta\nu}{T}}\, d\nu} = 3\frac{R}{N}T\,.$$

Submit two files to Canvas: your final PDF, and your LaTeX source file (which you can obtain from Overleaf by selecting Project, then Download as ZIP, then extracting the `.tex` file from the downloaded zip file).

[1]In the present note the model is discussed mainly in classical terms; nothing is proved about the quantized theory...