2023 年度 A セメスター 場の量子論 II / 場の量子論特論（担当: 大川 祐司）レポート問題

提出期限: 2024 年 1 月 26 日（金）
提出方法: ITC-LMS で PDF ファイルをアップロード

Answer all of the following problems in English or Japanese. All the problems are for the open bosonic string, and the doubling trick is implicitly assumed.

Problem 1
The BRST operator Q_B is an integral of the BRST current $j_B(z)$:

$$Q_B = \oint \frac{dz}{2\pi i}\, j_B(z)$$

with

$$j_B(z) = cT^{(m)}(z) + :bc\partial c:(z) + \frac{3}{2}\,\partial^2 c(z)\,,$$

where $T^{(m)}(z)$ is the energy-momentum tensor in the matter sector whose central charge c is given by $c = 26$.
(1) Show that $Q_B \cdot cV^{(m)} = 0$ for any primary field in the matter sector $V^{(m)}$ of weight 1.
(2) Show that $j_B(z)$ is a primary field of weight 1.
(3) Show that $Q_B^2 = 0$.

Problem 2
For the string field Ψ given by

$$\Psi = t\, c_1 \left|0\right\rangle + u\, c_{-1} \left|0\right\rangle + v\, L_{-2}^{(m)} c_1 \left|0\right\rangle,$$

calculate the following quantity:

$$\frac{V(t,u,v)}{T_{25}} = 2\pi^2 \left[\frac{1}{2} \left\langle\, \Psi, Q_B \Psi \,\right\rangle + \frac{1}{3} \left\langle\, \Psi, \Psi * \Psi \,\right\rangle \right]_{density}.$$