

# 1 Ασκήσεις, Κεφάλαια 10+11+12

1. Θεωρήστε  $\sigma \equiv \sigma^\mu = (\mathbb{I}_{2 \times 2}, \sigma_i)$ ,  $\bar{\sigma} \equiv \bar{\sigma}^\mu = (\mathbb{I}_{2 \times 2}, -\sigma_i)$ ,  $p \equiv p_\mu = (E, \vec{p})$ ,  $\bar{p} = (E, -\vec{p})$ . Δείξτε ότι  $(p \cdot \sigma)(p \cdot \bar{\sigma}) = (p \cdot \sigma)(\bar{p} \cdot \sigma) = (p \cdot \bar{\sigma})(\bar{p} \cdot \bar{\sigma}) = m^2 \mathbb{I}_{2 \times 2}$ .

2. Δείξτε ότι

$$\bar{u}_s(p)u_r(p) = -\bar{v}_s(p)v_r(p) = 2m\delta_{rs}$$

$$\bar{v}_s(p)u_r(p) = \bar{u}_s(p)v_r(p) = 0$$

$$u_s^\dagger(p)u_r(p) = v_s^\dagger(p)v_r(p) = 2E\delta_{rs}$$

$$u_s^\dagger(p)v_r(\bar{p}) = v_s^\dagger(p)u_r(\bar{p}) = 0$$

$$u_s^\dagger(p)u_r(\bar{p}) = v_s^\dagger(p)v_r(\bar{p}) = 2m\delta_{rs}$$

3. Δείξτε ότι

$$\sum_{s=1}^2 u_s(p)_\alpha \bar{u}_s(p)_\beta = (\not{p} + m)_{\alpha\beta}$$

$$\sum_{s=1}^2 v_s(p)_\alpha \bar{v}_s(p)_\beta = (\not{p} - m)_{\alpha\beta}$$

$$\sum_{s=1}^2 u_s(p)_\alpha u_s^\dagger(\bar{p})_\beta = (\not{p} + m)_{\alpha\beta}$$

$$\sum_{s=1}^2 v_s(p)_\alpha v_s^\dagger(\bar{p})_\beta = (-\not{p} + m)_{\alpha\beta}$$

4. Αποδείξτε τις σχέσεις (11.51), (11.52), (11.54), (11.55), (11.56), (11.89), (11.91) του Schwartz

5. Άσκηση 11.4, Schwartz

6. Άσκηση 11.1, Schwartz

7. Αποδείξτε τις σχέσεις (12.57), (12.59), (12.66), (12.81), (12.87), (12.89) του Schwartz