Exercise sheet 3

1. Mandelstam variables.
   Consider the scattering process $A + B \rightarrow C + D$.
   a.) Show that $s + t + u = m_A^2 + m_B^2 + m_C^2 + m_D^2$.
   b.) Express the cms energy of particle $A$ in terms of $s, t, u$ and/or the masses.
   c.) Express the lab energy of particle $A$ in terms of $s, t, u$ and/or the masses.
   d.) Express $s, t, u$ for elastic scattering of identical particles as function of the scattering angle.

2. An operator relation.
   Show that for a unitary matrix $U = \exp(iH)$ the relation
   \[ \det(U) = \exp(i \text{tr}(H)) \]
   is valid.

3. Consider the matrix
   \[ M = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \]
   a.) Is it in the group $O(2)$?
   b.) Is it in the group $SO(2)$?
   c) How does it transform the vector $(a_1, a_2)^T$?
   d) Does it describe a rotation of the plane?

Solutions are discussed Thursday, 13.09.18