Some exercises with matrix calculations
1. Calculate the determinant, the transposed matrix, the adjugate matrix and the inverse matrix of:

\[
A = \begin{pmatrix}
-4 & 1 & -5 \\
7 & 6 & 5 \\
-5 & 7 & 8
\end{pmatrix}
\]

2. The position of an object in two dimensions (2D) space can be represented either in Cartesian coordinate \((x,y)\) and in polar coordinate \((r,\theta)\). If the position of an object in Cartesian coordinate is: \(x=1, y=3\), transform the position in polar coordinate \((r,\theta)\).

Schrödinger Equation
3. Which are the assumptions in order to obtain the following expression for the probability behaviour of particles?

\[
\psi(x,t) = C e^{\frac{i}{\hbar}(xp_x - Et)}
\]

4. (a) Differentiate by time the expression given in the exercise above.
   (b) Differentiate by \(x\) the expression given in the exercise above.

Which two important operators are obtained?

5. Proof that the Hamiltonian Operator \(\hat{H}\) is Hermitian. What is the fundamental assumption needed to show that?

6. Proof the compatibility / complementarity of the following Operators:

\[
[\hat{t}, \hat{H}] \quad \text{and} \quad [\hat{x}, \hat{p}_x]
\]

What relationship do you find with the uncertainty principle? Discuss it!!

Optional

7. What is a Löwdin transformation? Why must we perform a Löwdin transformation before solving the eigenvalue problem of the Hamiltonian?

Interfaces – Search of new Materials with catalytic Properties.