

# Hermitian adjoint

The Hermitian adjoint of a matrix or operator  $\mathbf{A}$ , often written as  $\mathbf{A}^\dagger$ , especially when used in conjunction with the [bra-ket notation](#), is defined as the complex conjugate transpose of  $\mathbf{A}$ . Mathematically, if  $\mathbf{A}$  is an  $m \times n$  matrix, then

$$\mathbf{A}^\dagger = (\mathbf{A}^*)^T$$

where  $\mathbf{A}^*$  denotes the element-wise complex conjugate and  $T$  denotes the transpose.

In quantum mechanics, the Hermitian adjoint plays a crucial role in defining observables and ensuring that physical quantities are real-valued. An operator  $\mathbf{A}$  is called Hermitian if  $\mathbf{A} = \mathbf{A}^\dagger$ . Hermitian operators have real eigenvalues and orthogonal eigenvectors, which are essential properties for representing measurable quantities.

For example, if  $\mathbf{A}$  acts on a vector space with basis vectors  $|i\rangle$ , the matrix elements of the Hermitian adjoint are given by:

$$\langle i|\mathbf{A}^\dagger|j\rangle = \langle j|\mathbf{A}|i\rangle^*$$

This property is widely used in the manipulation of quantum states and operators.