Scalar: Tensor of Rank 0

It remains invariant under coordinate transformation.

for example size, mass, temperature, distance, speed et cetera are the scaler quantities, that is, they have only magnitude and no direction.

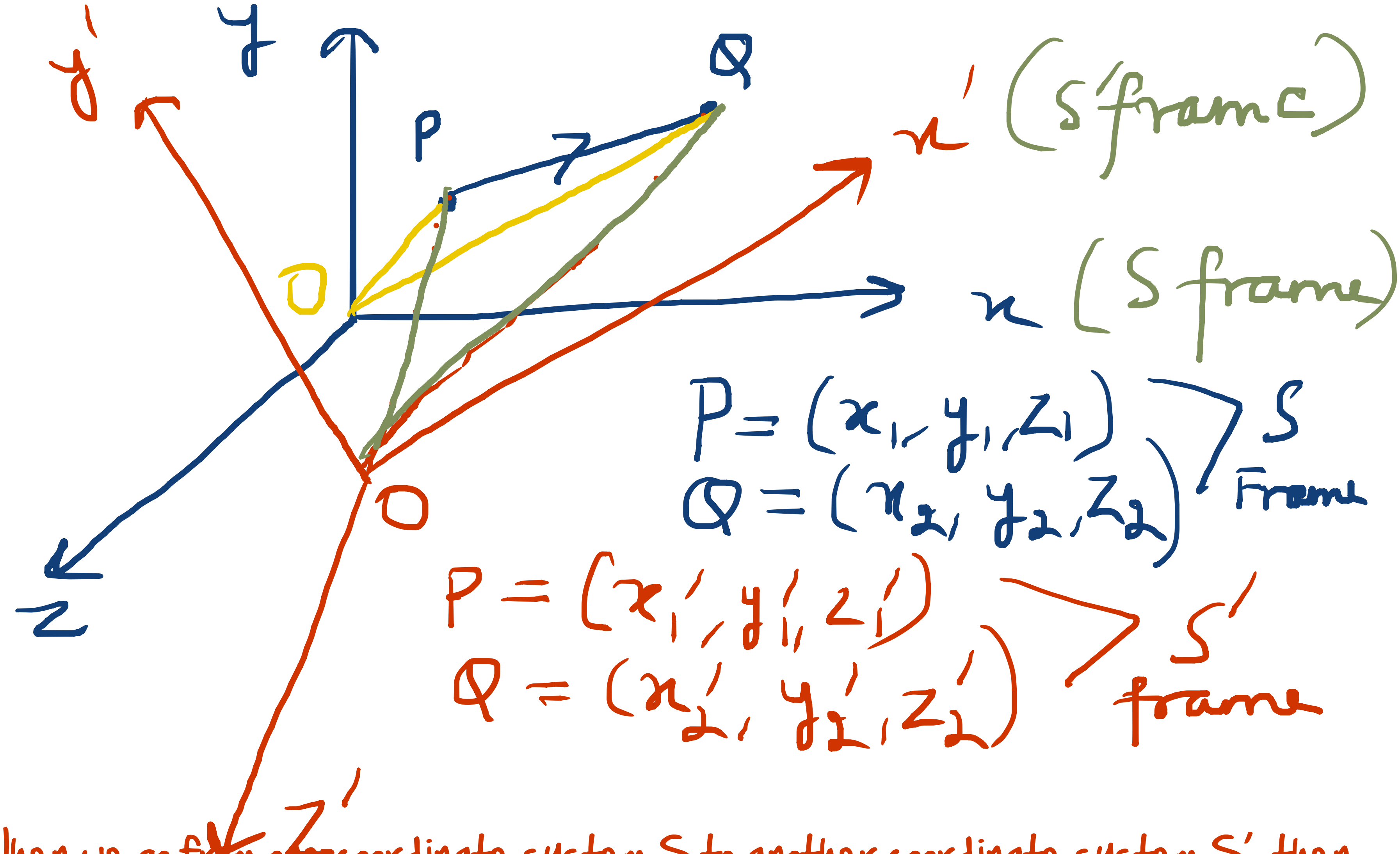
Hence they are independent of the coordinate transformation.

A scalar quantity is a tensor of rank zero, this means, that a scalar quantity requires zero or no basis to describe itself.

It is represented as A.

Vector: Tensor of Rank 1

It is a quantity which carries both magnitude as well as direction



When we go from one coordinate system S to another coordinate system S', then the components of P and Q in itself changes but the vector as such i.e. the nature of the vector does not change, its magnitude does not change, it is pointing from P to Q only in another frame of reference. This implies that if an object does not vary under coordinate transformation by following a set of transformation rules then that object is called as a tensor. The only thing that changes is the components of tensor.

A vector is a tensor of rank one that is it requires one basis vector (x or y or z) to describe its each component. For example A_y, A_z

In 3D (d=3), number of components of such a vector / tensor of rank 1 (n= 1) is 3 (i.e d^n)

Note that pseudo vector is not a tensor because it does not satisfy those transformation rules.

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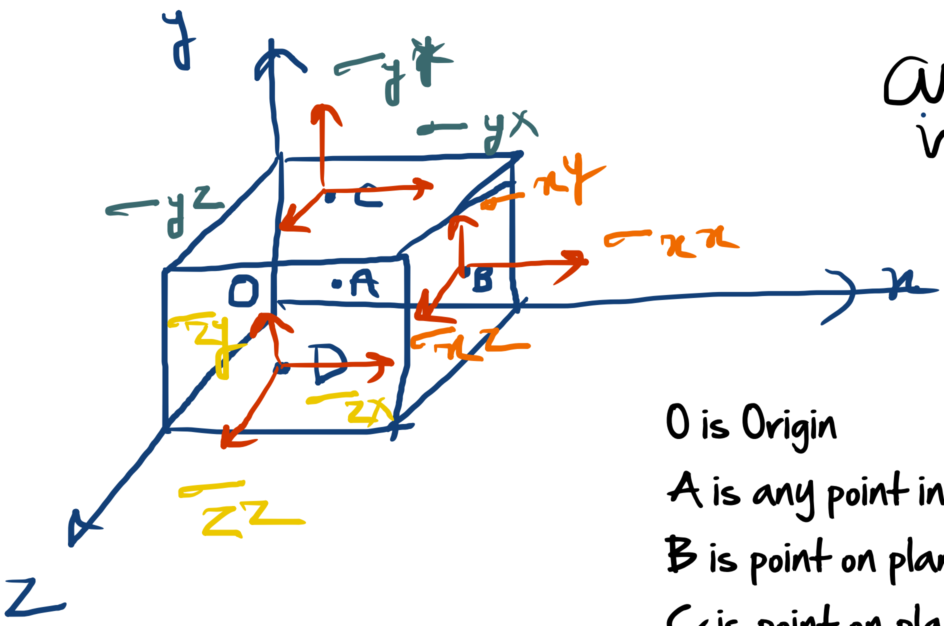
Stress Tensor: Tensor of Rank 2



T_{xy} → y: direction of Force

x ↓ area vector (plane)

O is Origin

A is any point in the interior facing all the stresses

B is point on plane with area vector x undergoing 3 stresses

C is point on plane with area vector y undergoing 3 stresses

D is point on plane with area vector z undergoing 3 stresses

Total Required Components to describe all forces at A: 9

3 elongations or stretching

6 shearing

Set of Basis Vectors required to describe each component n=2 (n is the rank of the tensor)

For eg xy, xz , yy ....etc

Dimension of system d= 3

So, the components of a rank 2 tensor in 3D is 3^2 = d^n = 9

Representation of a tensor of Rank 2: A_{xy}, A_{yz}, A_{ij} etc

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