# Joint Description for 42

# Concepts

- Each joint connects an “inner” and “outer” body
  - The spacecraft is assumed to have a tree topology, with the main body as the root of the tree
  - For each joint, the inner body is closer to the root of the tree
- Each joint may have 0-3 rotational DOF and 0-3 translational DOF
  - 3-DOF rotation may be GIMBAL or SPHERICAL
    - Motorized joints tend to be gimbals
    - Slosh pendulums, other examples may be spherical
- Each DOF may be locked for part or all of a sim run
  - Useful for modeling brakes, or mechanism failure cases
- Each DOF may have passive spring, damper
  - Useful for slosh, simple appendage flexibility modeling, etc

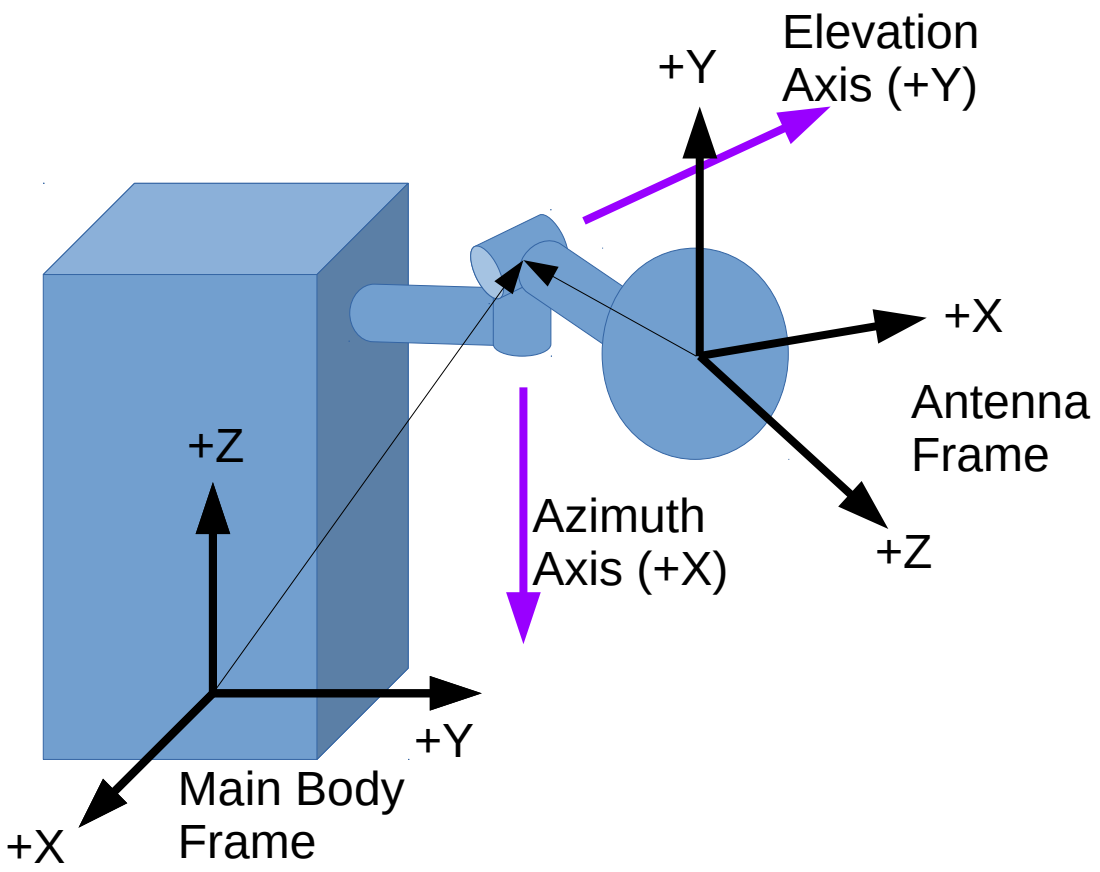
# Describing the Joint at Rest

- You need to supply the position of the joint with respect to the inner body frame and with respect to the outer body frame
- You need to supply “static angles” to reconcile offsets between the inner and outer body frames when the joint is undeflected

# Example:
# Spacecraft with Antenna

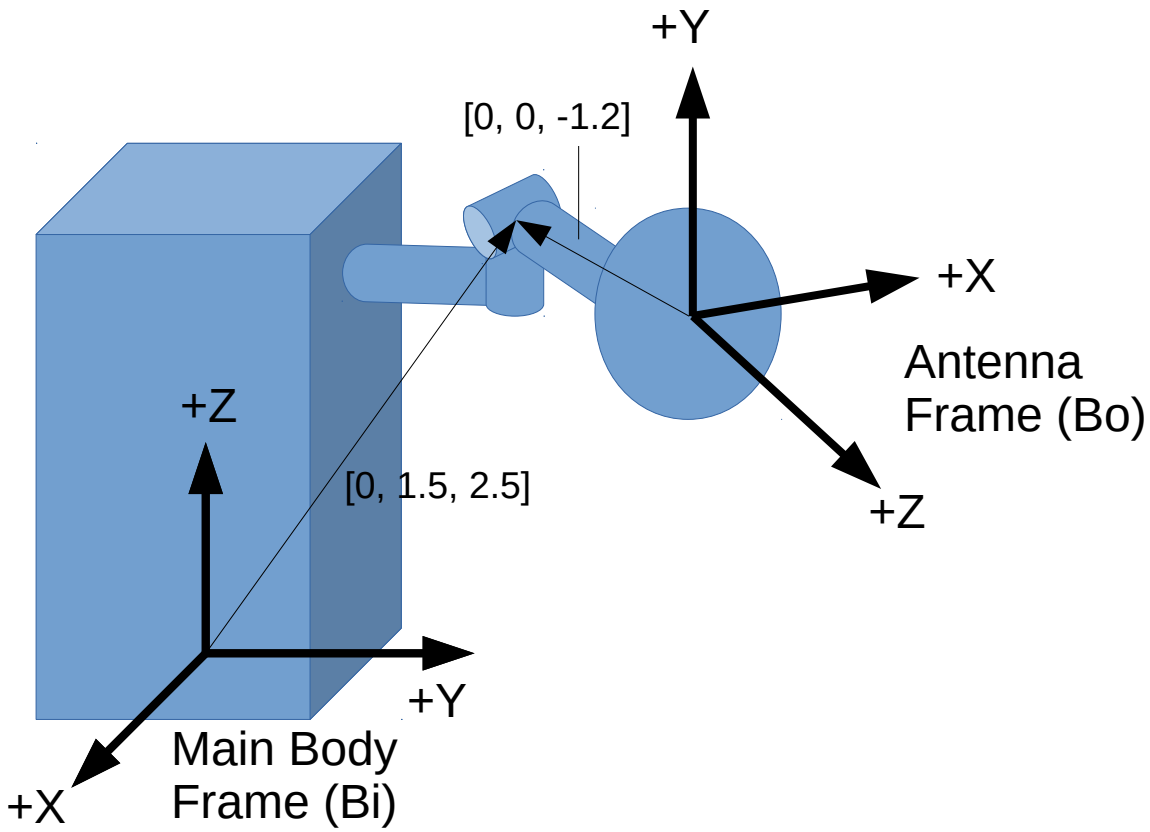
# Axis Definitions

- Gimbal angles are a 1-2-3 sequence through [Az, El, 0]
- All frames are right-handed!



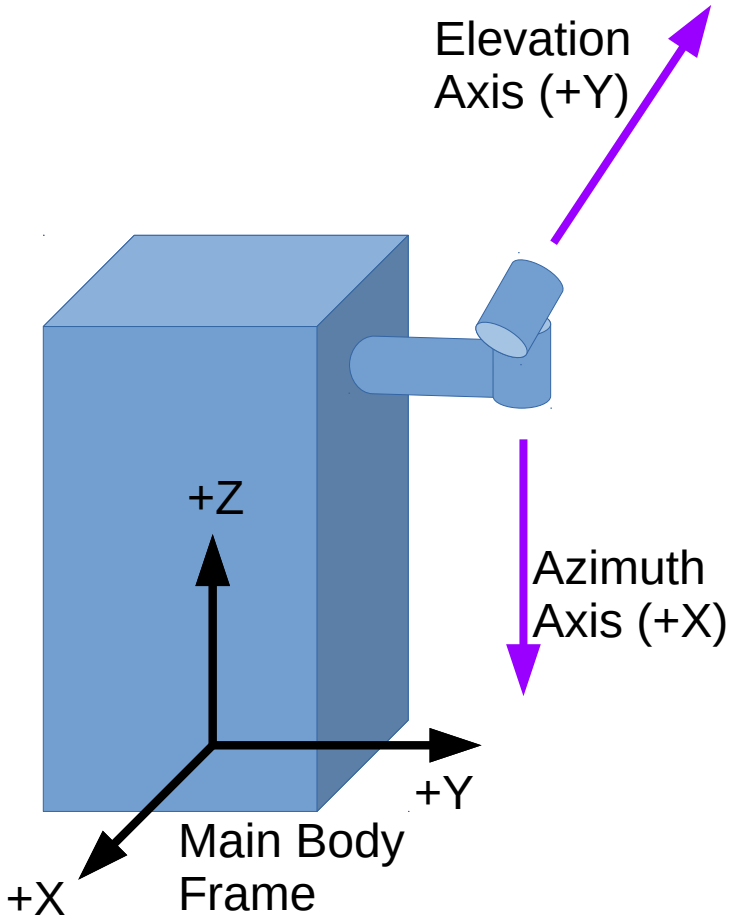
# Joint Positions wrt Inner and Outer Body Frames

- Position with respect to Bi frame is expressed in Bi frame: [0, 1.5, 2.5] m
- Position with respect to Bo frame is expressed in Bo frame:  [0, 0, -1.2] m



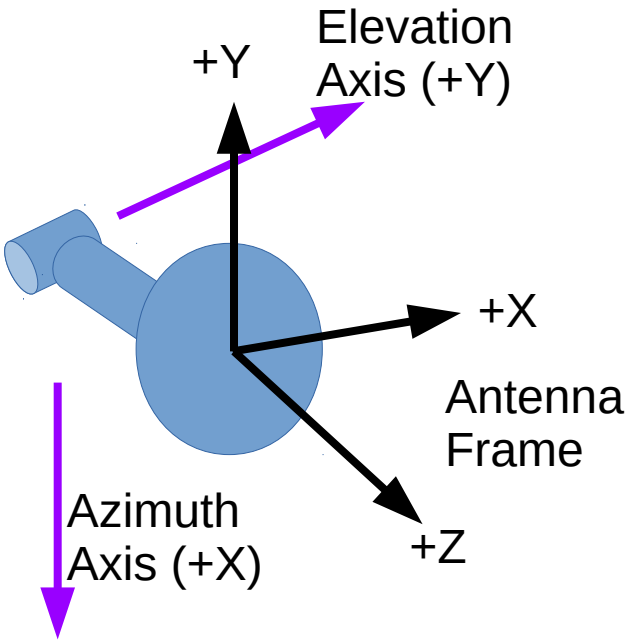
# Bi to Gi Static Angles

- Q: When gimbal angles are zeroed, what rotations are needed to get from main body frame to joint (Az-El) frame?
- A: A (Body-3) 2-1-3 Euler rotation through [90, -90, 0] deg is one option



# Go to Bo Static Angles

- Q: When gimbal angles are zeroed, what rotations are needed to get fro joint (Az-El) frame to Antenna frame?
- A: A (Body-3) 3-1-2 Euler rotation through [90, 0, 0] deg is one option

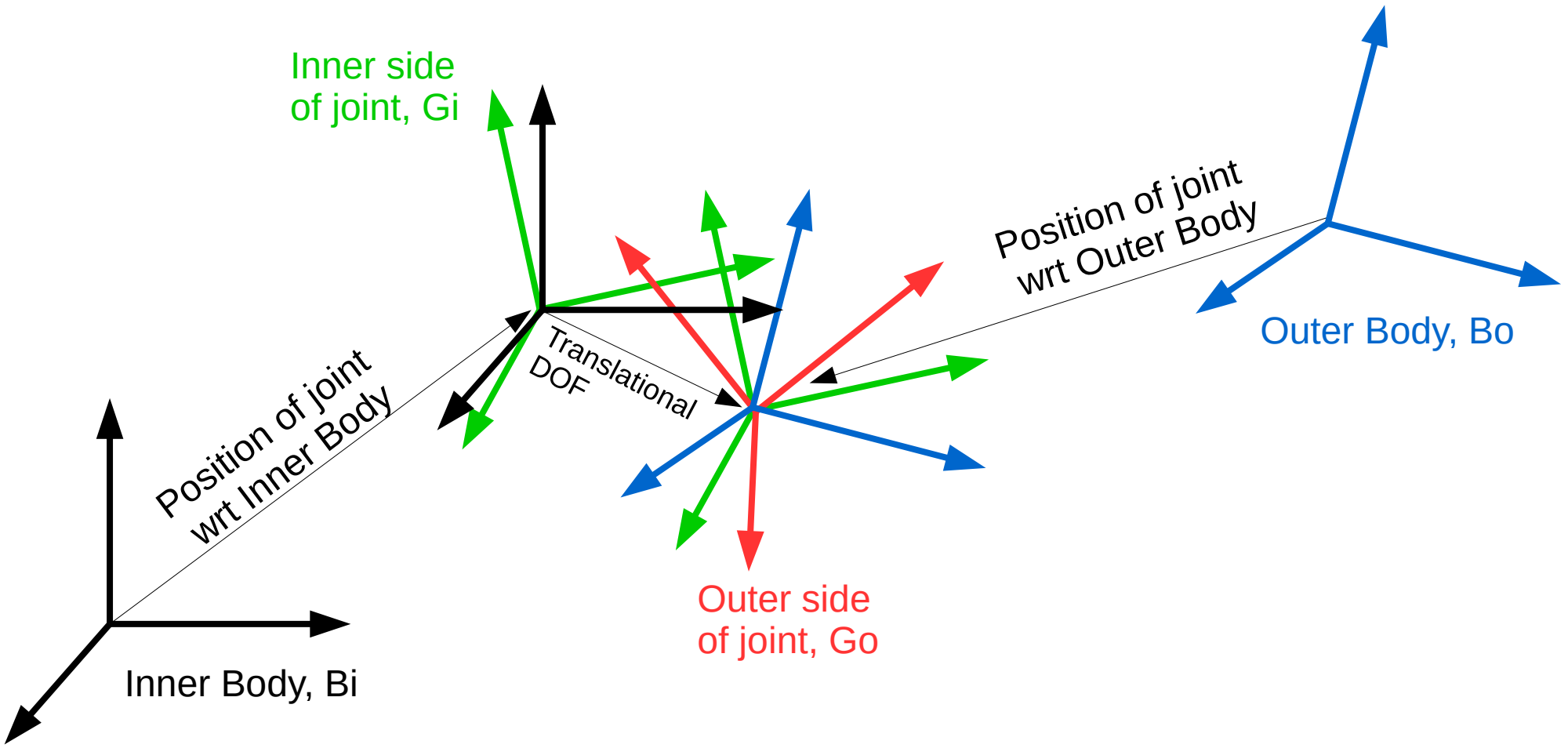


# Input File Section

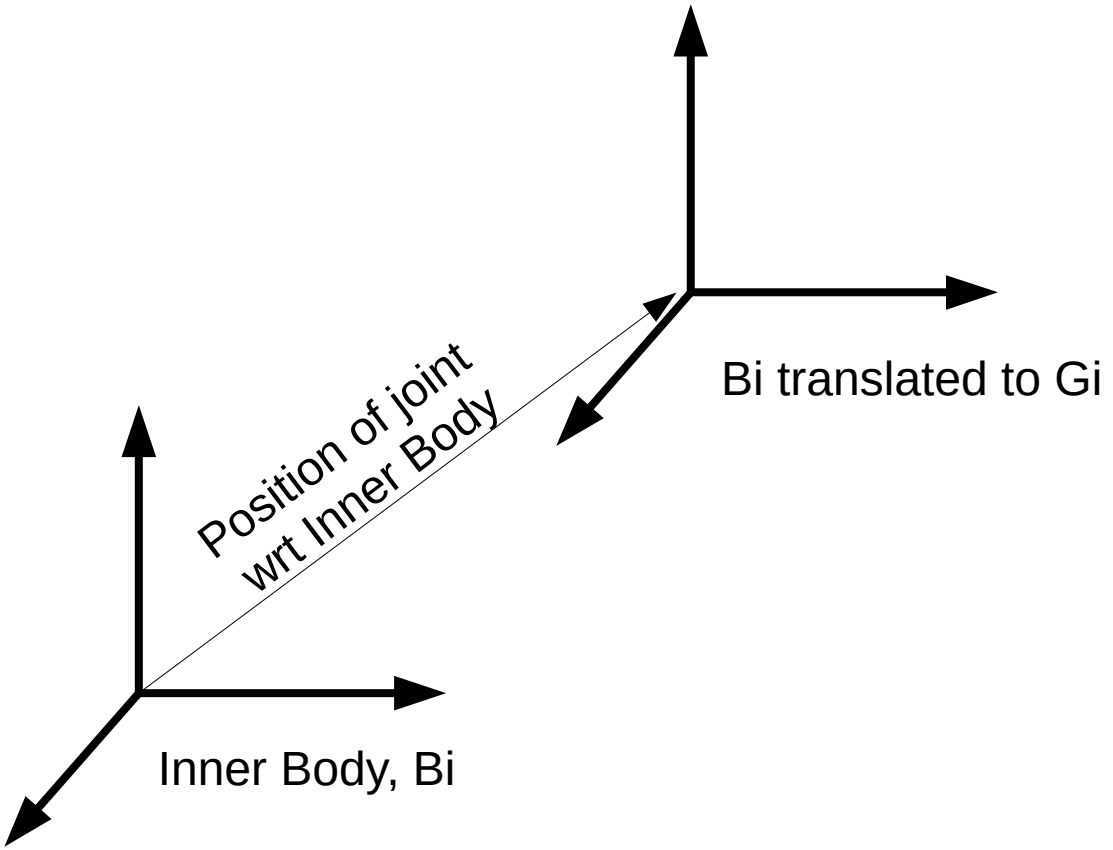
```
============================== Joint 0 ================================
0 1                                 ! Inner, outer body indices
2   123   GIMBAL                    ! RotDOF, Seq, GIMBAL or SPHERICAL
0   123                             ! TrnDOF, Seq
FALSE  FALSE  FALSE                 ! RotDOF Locked
FALSE  FALSE  FALSE                 ! TrnDOF Locked
0.0    0.0    0.0                   ! Initial Angles [deg]
0.0    0.0    0.0                   ! Initial Rates, deg/sec
0.0    0.0    0.0                   ! Initial Displacements [m]
0.0    0.0    0.0                   ! Initial Displacement Rates, m/sec
90.0 -90.0    0.0  213              ! Bi to Gi Static Angles [deg] & Seq
90.0   0.0    0.0  312              ! Go to Bo Static Angles [deg] & Seq
0.0   1.5   2.5                     ! Position wrt inner body origin, m
0.0   0.0  -1.2                     ! Position wrt outer body origin, m
0.0   0.0  0.0                      ! Rot Passive Spring Coefficients (Nm/rad)
0.0   0.0  0.0                      ! Rot Passive Damping Coefficients (Nms/rad)
0.0   0.0  0.0                      ! Trn Passive Spring Coefficients (N/m)
0.0   0.0  0.0                      ! Trn Passive Damping Coefficients (Ns/m)
```

# The Kinematic Chain from the Inner Body to the Outer Body through the Joint

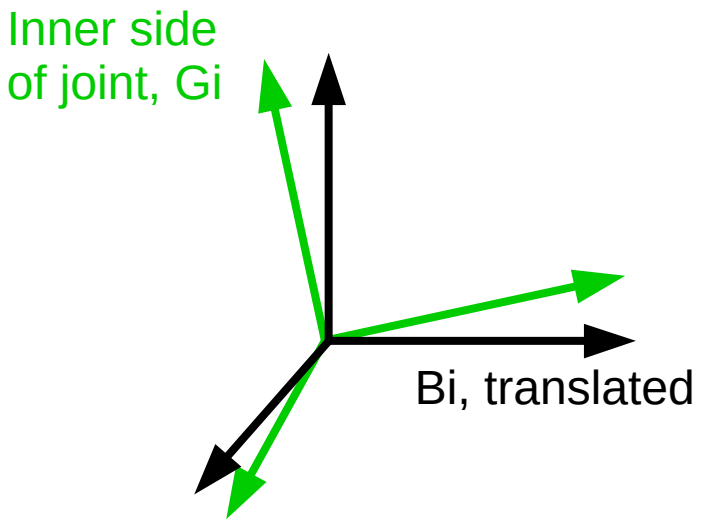
# The Kinematic Chain from Bi to Bo



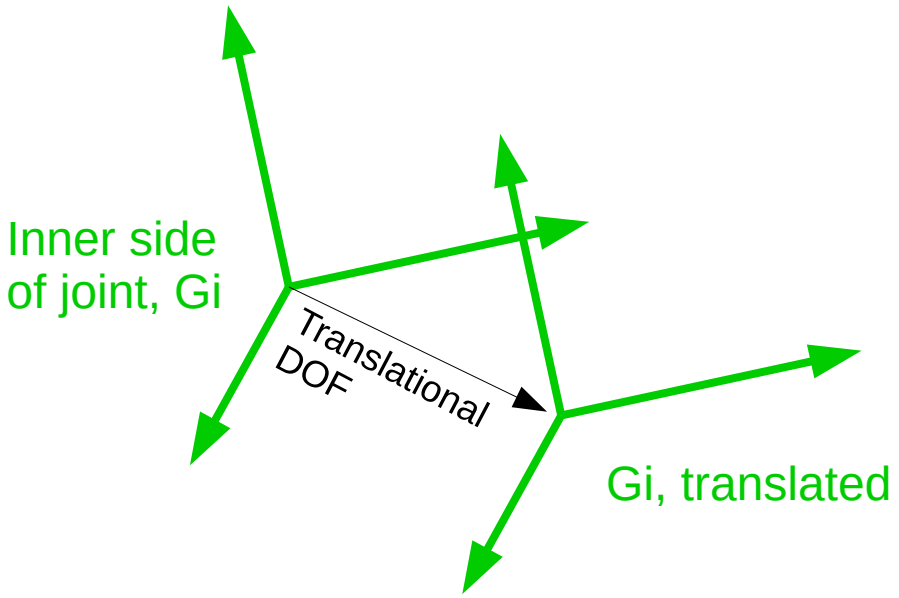
# Step 1: Translate from Bi Origin to Gi



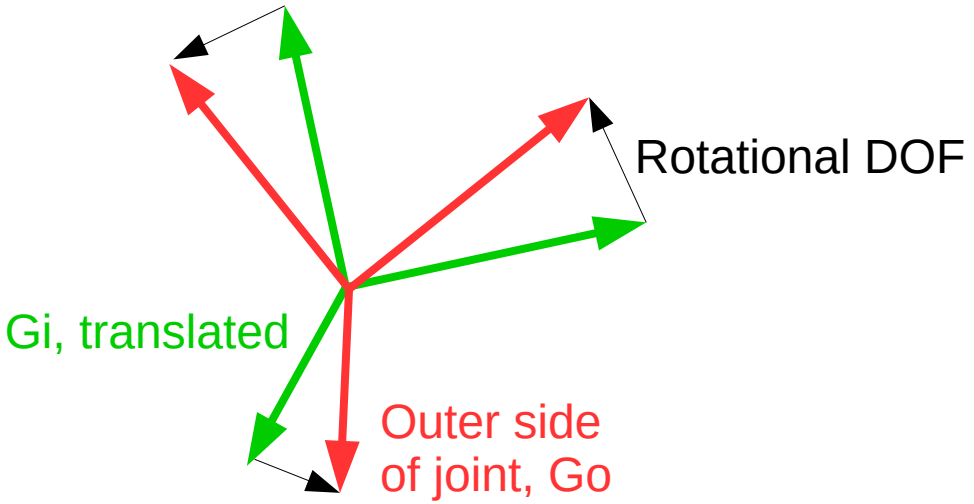
# Step 2:  Rotate from Bi to Gi



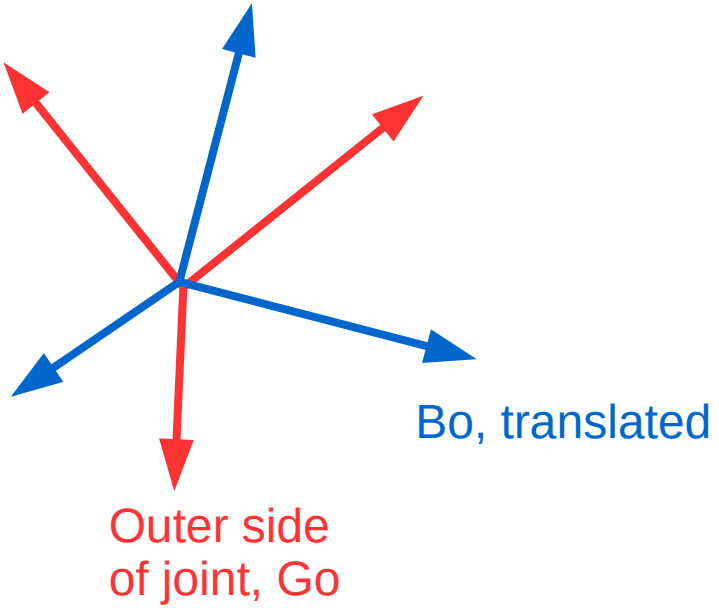
# Step 3:  Translate from Gi to Go



# Step 4:  Rotate from Gi to Go



# Step 5:  Rotate from Go to Bo



# Step 6: Translate from Go to Bo Origin