Derivation of NS with

The dimensional NS

Where is some ***dimensional*** force per unit volume.

non-dimensionalizing by

Substituting these expressions in we have

Or

Making this equation dimensionless yields

Collecting terms on the force yields

Therefore we have

Where the subscript variables are the prescribed "characteristic" values. These values are non-changing without loss of generality. Substituting and removing the asterisks yields

Where

We may write the term as

Writing this in expanded form, we have

Note that the diagonal is zero.

# Conservative form

Attempting to put this into a conservative form, we have

Note that we may use the product rule to write

And