

# Namelist "Gravity"

This data set is related to the characteristics of the gravity force.  
If no gravitational effect is considered, this namelist can be omitted.

## Full data set of the namelist

```
&Gravity Gravity_Enabled= .true. ,  
        Gravity_Angle_IJ= 0.0 ,  
        Gravity_Angle_IK= 90.0 ,  
        Reference_Gravity_Constant= 9.81D+00/
```

## Definition of the data set

### Gravity\_Enabled

- Type : boolean value
- The gravity effects are enabled or disabled
- Default value= .false.

### Gravity\_Angle\_IJ

- Type : real value
- Angle between the I-axis and of the projection of  $-\vec{G}$  on the IJ-plan (in degrees). The I-axis is the origin axis.
- Default value = 0.0

### Gravity\_Angle\_IK

- Type : real value
- angle between the K-axis and  $-\vec{G}$  (in degrees). The K-axis is the origin axis.
- Default value = 0.0

### Reference\_Gravity\_Constant

- Type : real value
- Reference value of the gravity constant
- Default value = 9.81

## IMPORTANT NOTE

The orientation of the gravity vector  $\vec{g}$  in the cartesian referential  $(\vec{I}, \vec{J}, \vec{K})$  is defined from the below formulation (spherical coordinates) :

$$\begin{aligned} G_I &= -G_0 \cos(\text{Gravity\_Angle\_IJ}) \sin(\text{Gravity\_Angle\_IK}) \\ G_J &= -G_0 \sin(\text{Gravity\_Angle\_IJ}) \sin(\text{Gravity\_Angle\_IK}) \\ G_K &= -G_0 \cos(\text{Gravity\_Angle\_IK}) \end{aligned}$$

Where  $G_0$  is norm of the force of gravity (or the buoyancy force).

### Remarks

The angle ranges are  $-90 \leq \text{Gravity\_Angle\_IJ} \leq +90$  and  $0 \leq \text{Gravity\_Angle\_IK} \leq +180$ .  
From the definition of angles, note that the vector  $\vec{g}$  is oriented along the  $-\vec{K}$  axis while  $\text{Gravity\_Angle\_IK} = 0$  and  $\vec{g}$  is in the plan IJ while  $\text{Gravity\_Angle\_IK} = 90$ .

Following the type of simulation and the choice on the form of equations (dimensional, dimensionless, the scales used in order to define the non-dimensional form of equations, etc ...), the term  $G_0$  can be written following different ways. For instance, the buoyancy force can be read as :  $F_b = (\rho - \rho_0).g_0$  in the momentum equations under Low Mach number hypothesis. In this case



- $G_0 = g_0$  where  $g_0$  is the constant of gravity.
- $\rho_0$  is the reference density defined in the namelist "Fluid\_Properties".

The buoyancy force can also be read as :  $F_b = -\rho_0.\beta.g_0.(T - T_0)$  in the momentum equations for incompressible flows under Boussinesq hypothesis. In this case

- $G_0 = \beta.g_0$  where  $\beta$  is the thermal expansion coefficient of the fluid considered.
- $T_0$  is the reference temperature defined in the namelist "Fluid\_Properties".

As a consequence the generalized form of  $G_0$  in the code is :  $G_0 = \beta.g_0$  where  $g_0$  is defined from the data "Reference\_Gravity\_Constant" and  $\beta$  from the data "Thermal\_Expansion\_Coefficient" (in the namelist "Fluid\_Properties").

The Default values of these variables are :

- Reference\_Gravity\_Constant = 9.81
- Thermal\_Expansion\_Coefficient = 1.0

These values are automatically taken into account by the code if these variables are not explicitly modified by the user in the data file.

**Clearly, the variable "Thermal\_Expansion\_Coefficient" is only needed in the simulations of incompressible flows with thermal buoyancy effect .**



In every other cases, it can be omitted because the buoyancy/gravity force can be defined from the variable "Reference\_Gravity\_Constant" only.

From:

<https://sunfluidh.lisn.upsaclay.fr/> - Documentation du code de simulation numérique  
**SUNFLUIDH**

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