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## Operator PROJ\_CHAMP

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### 1 Drank

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the goal of the operator is to result project the fields of a data structure on another mesh. This command can be used for example to transfer on a “mechanical” mesh, result of a thermal computation carried out on a “thermal” mesh different.

One can also “continue” a thermal computation (or mechanics) on another mesh (more or less refined).

The command also makes it possible to define “zones” (geometrical) which one projects the ones on the others what makes it possible to solve the problem of a desired discontinuity of the field project (for example along the lips of a crack).

For reasons of performances CPU, one can initially calculate the geometrical pairing of the two meshes and store data structure produced in a concept which one will be able to re-use later to carry out the projection of the fields.

It is possible to project an “isolated” field or a set of fields resulting from a SD\_RESULTAT.

Product a data structure SD\_RESULTAT or an “isolated” field or a data structure CORRESP\_2\_MAILLA.

## 2 Syntax

```
resu = PROJ_CHAMP (  
  # does one want to project fields or wishes one right compute  
  # the matrix of projection?  
  ◊PROJECTION=/          "OUI" ,          [DEFAULT]  
                        / "NON" ,  
  
  # does one want to use a matrix of projection calculated as a preliminary?  
  ◊MATR_PROJECTION=matproj ,  
[corresp_2_mailla]  
  
  # choice of the method of projection:  
  Are ◊METHODE=/          "AUTO" ,  
[DEFAULT]  
                        / "COLLOCATION" ,  
                        / "ECLA_PG" ,  
                        / "NUAGE_DEG_0" ,  
                        / "NUAGE_DEG_1" ,  
                        / "COUPLAGE" ,  
                        / "SOUS_POINT" ,  
  
  # which the 2 meshes in opposite?  
  ◊♦/MODELE_1          =mo1 ,          [model]  
    /MAILLAGE_1      = ma1,          / [mesh]  
                                     / [squelette]  
  ♦/MODELE_2          =mo2 ,          [model]  
    /MAILLAGE_2      = ma1,          [mesh]  
  
  # which does one want to project? An isolated field or a sd_resultat ?  
  ◊/CHAM_GD          =champ1/          [cham_gd_sdaster  
    /RESULTAT      =evol ,          / [evol_ther]  
                                     / [evol_elas]  
                                     / [evol_noli]  
                                     / [evol_char]  
                                     / [dyna_harmo]  
                                     / [dyna_trans]  
                                     / [mode_meca]  
                                     / [mode_stat_depl]  
                                     / [base_modale]  
                                     / ...  
  
  # key keys additional for method "COLLOCATION" :  
  ◊◊CAS_FIGURE=/          "3D" ,  
                        / "2D" ,  
                        / "2.5D" ,  
                        / "1.5D" ,  
  
  # to transform the geometry of the nodes of the meshes:  
  ◊TRANSF_GEOM_1=          (fx, fy, [fz])  
[function]  
  ◊TRANSF_GEOM_2=          (fx, fy, [fz])  
[function]  
  ◊DISTANCE_MAX=d_max ,          [R]  
  ◊ALARME=/          "OUI" ,          [DEFAULT]  
                        / "NON" ,  
  ◊PROL_ZERO=/          "NON" ,          [DEFAULT]  
                        / "OUI" ,  
  additional ◊TYPE_CHAM=' NOEU
```

```
" # key word for methods "NUAGE_DEG_0/1"
◇CHAM_NO_REFE=chno2 , [cham_no]

# key word additional for method "SOUS_POINT"
◇♦CARA_ELEM =carac , [cara_elem]

# to transform the geometry of the nodes of the meshes:
◇TRANSF_GEOM_1= (fx, fy, [fz])
[function]
◇TRANSF_GEOM_2= (fx, fy, [fz])
[function]

# If the fields of a sd_resultat are projected:
◇◇#Sélection of the /TOUT_CHAM
fields = ' OUI' , [DEFAULT]
/NOM_CHAM =l_noch , [l_Kn]

◇#Sélection of the /TOUT_ORDRE
sequence numbers = ' OUI' ,
[DEFAULT]

/NUME_ORDRE =l_nuor , [l_I]
/♦/INST=l_inst , [l_R]
/FREQ =l_freq , [l_R]
/LIST_INST=l_inst , [listr8]
/LIST_FREQ=l_freq , [listr8]
◇ / CRITERE=' RELATIF' , [DEFAULT]
PRECISION=/1.E-6 , [DEFAULT]
/prec , [R]
/CRITERE = ' ABSOLU' ,
PRECISION=prec ,

# To impose the classification of the cham_no (modes):
◇ NUME_DDL=nu [nume_ddl_sdaster]

# If one wishes to make a pairing "by zones":
◇VIS_A_VIS = ( _F (
♦ | TOUT_1=' OUI' ,
| GROUP_MA_1=lgamma1 , [l_gr_maille]
| MAILLE_1=lmail1 , [l_maille]
| GROUP_NO_1=ligno1 , [l_gr_noeud]
| NOEUD_1=lnoe1 , [l_noeud]
♦ | TOUT_2=' OUI' ,
| GROUP_MA_2=lgamma2 , [l_gr_maille]
| MAILLE_2=lmail2 , [l_maille]
| GROUP_NO_2=ligno2 , [l_gr_noeud]
| NOEUD_2=lnoe2 , [l_noeud]
◇ # if method "COLLOCATION":
◇CAS_FIGURE=/ "3D",
/ "2D",
/ "2.5D",
/ "1.5D",
◇TRANSF_GEOM_1= (fx, fy, [fz])
[function]
◇TRANSF_GEOM_2= (fx, fy, [fz])
[function]
),),
```

```
◇NOM_PARA will =lpara , [l_Kn]
◇TITER =titr , [l_Kn]
);
```

Type of result of the operator:

- if one uses key word PROJECTION=' NON', resu is a "matrix of projection" (standard corresp\_2\_mailla),
- if key word CHAM\_GD is used, resu is a field of comparable nature that champ1 ,
- if key word RESULTAT is used, resu is a standard SD\_RESULTAT in the same way than evol.

## 3 Operands

### 3.1 Operands PROJECTION and MATR\_PROJECTION

the operator can be used in 3 different ways. Key keys PROJECTION and MATR\_PROJECTION allow these various uses.

#### 3.1.1 Computation “at a stretch”

It is the by default mode. One calculates a geometrical correspondence initially (called matrix of projection), then one uses this matrix to project the fields to be projected. The matrix of projection is lost at the end of the operator.

#### 3.1.2 Computation of the matrix of projection

One calculates the geometrical correspondence and one stops. The matrix of projection is the result concept of the command.

Note: this kind of computation is currently possible only with methods “COLLOCATION” or “COUPLAGE”.

#### 3.1.3 Use of a matrix of projection

One uses the matrix calculated previously to project the fields.

Note: If one wants to project fields not elements, key word MODELE\_2 should be used.

#### 3.1.4 Examples

to do a calculation “at a stretch”, one writes for example:

```
TEMP2=PROJ_CHAMP (RESULTAT=TEMP1, METHODE=' COLLOCATION',  
                 MAILLAGE_1=MA1, MAILLAGE_2=MA2, NOM_CHAM=' TEMP')
```

to do a calculation in two times, one writes:

```
MATPROJ=PROJ_CHAMP (METHODE=' COLLOCATION', PROJECTION=' NON',  
                  MAILLAGE_1=MA1, MAILLAGE_2=MA2,)
```

```
TEMP2=PROJ_CHAMP (RESULTAT=TEMP1, MATR_PROJECTION=MATPROJ, NOM_CHAM=' TEMP')
```

## 3.2 Operand METHODE

There exist five methods of projection.

Methods “COLLOCATION” and “NUAGE\_DEG\_0/1” are adapted to projection of the fields at nodes . Method “COLLOCATION” is to be used in priority: it is most robust and she does not extrapolate the values of the initial field. Two methods “NUAGE\_DEG\_0/1” can be used if one cannot make differently. For example, when the initial mesh does not contain meshes, but only nodes (for example a mesh containing the positions of transmitters).

#### Notice on the method collocation:

For the projection of fields “NOEU” or “ELNO”, there exists an alternative to PROJ\_CHAMP for certain particular configurations of projection, in particular met in THM for the postprocessing of the pressure. If the user wishes to project result quadratic mesh on the same linearized mesh, it can use MACR\_ADAP\_MAIL (ADAPTATION=' MODIFICATION',  
DEGRE=' OUI', MAJ\_CHAM=\_F (...),), which can prove on the large studies sometimes faster.

Method “ECLA\_PG” is adapted to the fields with Gauss points (ELGA).

One wishes to be able to project in the same command of the fields at nodes and fields ELGA. For that, key word METHODE admits value “AUTO”. In this case, one will use method “COLLOCATION” for the cham\_no and “ECLA\_PG” for the cham\_elem/ELGA.

Another method, named "COUPLAGE" was introduced for computations of interaction fluid-structure when *Code\_Aster* is coupled with the code of mechanics of the fluids Saturn. This method is comparable to collocation.

a named method "SOUS\_POINT" , is used to build fields of command variables on mechanical models at subpoints from a field or of result resulting from a computation on a model 3D.

## 3.2.1 Méthode= "COLLOCATION"

first method (COLLOCATION) is classical: to compute: the value on a node ( $N2$ ) of the mesh  $ma2$  , one seeks in which element of the mesh  $ma1$  this node is, then one interpolates the value using the shape functions of this element.

When the node is not geometrically inside one of the elements of  $ma1$  (i.e., apart from the modelled geometrical field), the method connects the node and the point of the element nearest and interpolates the value using the shape functions of this element. There is thus (by default) a "prolongation" of the field outside the mesh initial. Operand DISTANCE\_MAX makes it possible to modify this behavior.

### Problem posed by the "mixed" fields:

If the components carried by the various nodes of element of  $ma1$  are not all the same ones, for example, if the nodes tops do not carry the same components that the nodes mediums, one cannot use "stupidly" the interpolation by the shape functions of the element.

The computation of the value of a component on the node  $N2$  is made in the following way:

1) Geometrical stage (made independently of the fields project):

One determines the element  $ima1$  associated with  $N2$  , then one calculates, with the shape functions of this element, the weight coefficients for **all** the nodes of  $ima1$  . The sum of these coefficients is worth 1.

2) Stage of projection of a component of a field:

- If all the nodes of  $ima1$  carry this component, there are no problems, one applies the formula of weighting selected.
- If the component is not carried by **all** the nodes of  $ima1$  :
  - Si some nodes carrying the component has a "weight"  $> 0$  , one makes use of those by modifying the formula of weighting so that the sum of the coefficients selected makes 1.
  - Si none nodes carrying the component has a weight  $> 0$  , one is satisfied of the components to make an arithmetic mean present on  $ima1$  .

## 3.2.2 Méthode= "NUAGE\_DEG\_1/0"

the second family of methods (NUAGE\_DEG\_1/0) (**strongly disadvised**) uses the notion of groups of dots, by forgetting the finite elements present in the models. It is more general than method "COLLOCATION" because it makes it possible to project a field at nodes without these nodes being carried by of the finite elements (for example a set of sensors). On the other hand, this method often disturbs the users familiar of the finite element method because it is purely geometrical and does not see the material borders nor the holes: the computed value on a node of the new mesh depends on **all** the nodes which are close for him. In the zones of strong gradient, the values can be obtained with a strong extrapolation, which is seldom "physical".

The idea of these methods is to make pass "as well as possible" a hyperplane of degree 1 or 0 (NUAGE\_DEG\_1/0) among the points of mesh 1. The weight of the points is very strongly dependant on their distance to the node is outside the field of definition with a right profile of the EXCLU type node:  $N2$  the weight decrease like exponential decreasing distance. Once the coefficients of the calculated hyperplane (for a node  $N2$ ), one evaluates this hyperplane with the coordinates of the node  $N2$  .

## 3.2.3 Méthode= "ECLA\_PG"

third method (ECLA\_PG) makes it possible to project fields known with Gauss points of the mesh (also called points of integration). For example, it is possible to project stress fields, strains or local variables.

This method is based on joint use of the command MACR\_ECLA\_PG and of the method of "COLLOCATION" described previously. Each mesh of the initial mesh is burst in as much of under-meshes that of Gauss points contained in the mesh, of the same way as the current bursting of MACR\_ECLA\_PG. In the second time, one uses the matrix of projection of method "COLLOCATION" between Gauss points of the second mesh and the meshes previously burst.

Remarks concerning the pyramidal elements with 27 Gauss points:

- On the 27 Gauss points of this diagram of integration, 12 are located in "outside" of the pyramid. Their values are ignored during projection, because one does not wish only one pyramidal element of the mesh "1" influences elements of the mesh "2" which do not have a geometrical intersection with him; it would be the case of an element close to the border between 2 different materials which could influence the elements located on other side of the border.
- On the 15 Gauss points located inside, one preserves only 8 points because one did not know "to cut out" a pyramid in 15 subelements of simple form. On the whole, for a pyramid of the mesh "1", only 8 Gauss points will be used during projection.
- For a pyramid of the mesh "2", it is necessary Gauss points to give a value to the 27. So that the 12 external points are affected by an "interior" value, one carries out a homothety to bring back them inside the pyramid.
- The projection of the pyramids with 27 Gauss points is thus very "debatable". The only guarantee is that the value of the field after projection is well that of a Gauss point of the field "origin" (without interpolation nor extrapolation) and that the recopied point is a point geometrically close to the "target" Gauss point. This development was carried out to allow the projection of fields ELGA on complex models (formed by different element types) by hoping that the pyramids are very few (some zones of connection).

## 3.2.4 Méthode= "COUPLAGE"

fourth method (COUPLAGE) is an alternative very close to the collocation and specifically introduced for the coupling with the code of mechanics of the fluids Saturn (in finished volumes). It is employed in the macro-command CALC\_IFS\_DNL which allows this coupling YEWS.

It is available only to generate data structure CORRESP\_2\_MAILLA (case PROJECTION='NON'). It makes it possible to project fields at nodes between a mesh with the finite elements (structure) and meshes coming from the code to finished volumes Code\_Saturne. These meshes, imported in Code\_Aster, are composed of point elements, because there are no shape functions associated.

## 3.2.5 Méthode= "SOUS\_POINT"

This method is also based on the method of "COLLOCATION" and is similar to method ECLA\_PG by removing the stage of bursting of the mesh. The inputted fields are cham\_no or CHAM\_ELEM/ELNO in the form of field isolated or contents as a result from evolther TYPE. The first stage consists in building a mesh starting from the coordinates of the subpoints of the MODELE\_2 (models mechanical) for all the points of the families of the list MATER

the inputted fields are then projected on this mesh by a method of "COLLOCATION" (by forcing the type of the fields created with cham\_no). Finally the values obtained for each point are recopied in A CHAM\_ELEM/ELGA, on the corresponding points and subpoints (see V1.01.318).

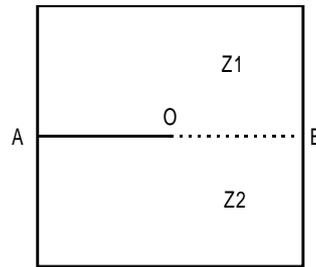
This method is prohibited with the key word VIS\_A\_VIS and with PROJECTION = "NON".

## 3.3 Key word VIS\_A\_VIS

This key word optional factor makes it possible to project the field "per pieces". By default, it is the **group** of the field which is project.

This key word makes it possible to project discontinuous fields or to solve the problem of the projection of complex models (see [§3.3.3]).

If it is used this key word makes it possible to the user to project a field (with the nodes) a priori discontinuous (on one line or a surface) and to preserve this discontinuity for the field project:



Appear 3.3-a: fissured structure.

For example, that is to say the fissured structure of the figure [3.3-a]. The field of displacement is discontinuous on crack: the upper lips and lower although geometrically confused have each one their own field of displacement.

Let us suppose that one has 2 meshes ( $M$  and  $M'$ ) different from this structure and that for each one of these meshes, the zones  $Z1$  and  $Z2$  are represented by two `GROUP_MA` named  $Z1$  and  $Z2$ .

One will be able to write:

```
VIS_A_VIS = ( _F ( GROUP_MA_1 = "Z1" , GROUP_MA_2 = "Z1" ),  
              _F ( GROUP_MA_1 = "Z2" , GROUP_MA_2 = "Z2" ) ),
```

the values of the field project on the upper lip (pertaining to  $Z1$ ) will take account only values of the initial field on  $Z1$ . In the same way the values obtained on the lower lip depend only on the initial field on  $Z2$ .

**Notice on the use of `VIS_A_VIS` + field `ELNO` :**

One could believe that the use of key word `VIS_A_VIS` makes it possible to project a field `ELNO` by preserving a discontinuity on the interface between two zones. It of it is nothing as one explains it to the § [12].

### 3.3.1 Operands `TOUT_1 / GROUP_MA_1 / MAILLE_1 / GROUP_NO_1 / NOEUD_1`

These operands are used to define the group of meshes ("`COLLOCATION`", "`ECLA_PG`",) or of the nodes ("`NUAGE_DEG_1/0`") to take into account in the initial mesh.

### 3.3.2 Operands `TOUT_2 / GROUP_MA_2 / MAILLE_2 / GROUP_NO_2 / NOEUD_2`

These operands are used to define all the nodes or the elements where one evaluates to it (S) field (S).

### 3.3.3 Use of key word `VIS_A_VIS` to project the complex models

key word `VIS_A_VIS` makes it possible for example 3D to solve the problem of the projection of a field of temperature calculated on a model containing of the elements and the shell elements (a solid whose skin interns would be covered with a "liner" with a grid in shell elements).

The problem is the following: the elements 3D carry on their nodes only degree of freedom `TEMP`, whereas the shell elements (thermal) carry the 3 degree of freedom: `TEMP_MIL`, `TEMP_INF` and `TEMP_SUP`. If one does not take precautions and that one projects all the model only one blow, degree of freedom `TEMP_MIL`, `TEMP_INF` and `TEMP_SUP` "will be lost" during projection. Indeed, as the initial mesh contains voluminal elements, it is the procedure "3D" which is applied: for each node of mesh 2, one seeks a voluminal mesh which contains this node (or which of it is close). Once this found mesh, one interpolates the degrees of freedom carried by all the nodes of this mesh. Practically, no mesh 3D can carry on all its nodes degrees of freedom `TEMP_MIL`, `TEMP_INF` and `TEMP_SUP`; those are thus lost.

To solve this problem it is necessary to do something like:

```
evo2= PROJ_CHAMP (RESULTAT=evol,...  
                 VIS_A_VIS= ( _F (GROUP_MA_1: "VOLU" , GROUP_MA_2=' VOLU',),
```

`_F (GROUP_MA_1: "LINER", GROUP_MA_2=' LINER',),)`  
Of this way, meshes "LINER" of mesh 2 will be assigned by the values carried by meshes of "LINER" of mesh 1 and they will carry the same degrees of freedom.

## 3.4 Operands MODELE\_1, MAILLAGE\_1

```
/MODELE_1 = mo1,  
/MAILLAGE_1 = ma1,
```

These two keys key make it possible to specify the mesh (or squelette in the case of the substructuring) initial. Projection goes from the mesh "1" towards the mesh "2".

This mesh is that which is associated with the fields to project (`evol1` or `champ1`)

Note:: it is preferable to use key word `MODELE_1`, because that makes it possible to limit meshes the candidates to projection (so the model is more restricted than the mesh).

## 3.5 Operands MODELE\_2, MAILLAGE\_2

```
/MODELE_2 = mo2,  
/MAILLAGE_2 = ma2,
```

These two keys key make it possible to specify the final mesh. It is the mesh on which will be created the projected fields.

### Notice important:

*There still, it is preferable to use key word `MODELE_2`, even if the finite elements of `MODELE_2` are not used. One makes use only of the coordinates of the nodes of the mesh (`ma2`) associated with `mo2`. The fact of using the name of the model rather `mo2` () than the name of the mesh (`ma2`) makes it possible to avoid construction some nodes (located very far) which sometimes strongly deteriorates performances (CPU) of projection.*

## 3.6 Operand RESULTAT

```
RESULTAT = evol,
```

Name of the result concept which one wants to project.

### Note:

*For a `evol_noli`, the result concept will not contain (by default) only the fields of displacements. To compute: the stress fields and of local variables correspondings, it is preferable to use command `STAT_NON_LINE` by means of key word `PREDICTION: "DEPL_CALCULE"`.*

## 3.7 Operand CHAM\_GD

This key word is used to indicate the field to be projected (when one does not project a `sd_resultat`).

For methods "NUAGE\_DEG\_1/2" the field must be a `cham_no`.

For method "ECLA\_PG", the field must be a `cham_elem/ELGA`

## 3.8 Operand CHAM\_NO\_REFE

For methods "NUAGE\_DEG\_1/2" the field provided behind `CHAM_NO_REFE` is a `cham_no` "models" for the fields at nodes to create during projection. This key word is compulsory.

When one projects an "isolated" field (for example of `TEMP_R`), it is necessary to provide a `cham_no` of same quantity (`TEMP_R`).

When the fields of a `sd_resultat` are projected, since key word `CHAM_NO_REFE` has only one value, one sees that one will not be able (in general) to project several different `NOM_CHAM`

## 3.9 Operand CAS\_FIGURE

This key word (optional) is used to direct method "COLLOCATION" towards one of the 4 following cases:

- 1) "3D" the only elements of the mesh "1" which will be used for projection are the voluminal elements: hexahedrons, pentahedrons, tetrahedrons and pyramids. The nodes have 3 cordonnées  $(X, Y, Z)$ .
- 2) "2D" the only elements of the mesh "1" which will be used for projection are the surface elements: quadrangles and triangles. The mesh is supposed to be plane. The nodes have 2 cordonnées  $(X, Y)$ .
- 3) "2.5D" the only elements of the mesh "1" which will be used for projection are the surface elements: quadrangles and triangles. The mesh is "3D". The nodes have 3 cordonnées  $(X, Y, Z)$ . It is the case of the "shells" plunged in 3D.
- 4) "1.5D" the only elements of the mesh "1" which will be used for projection are the linear elements: segments. The mesh can be 2D or 3D. The nodes have 2 or 3 cordonnées  $(X, Y, (Z))$ .

This key word can also be used under key word VIS\_A\_VIS. It can change value according to the occurrences.

If the user does not inform this key word, the program adopts following logic:

One meshes traverses the list of model 1 candidates with being projected (this list can be filtered thanks to key word VIS\_A\_VIS)

- 1) if there exists at least 1 3D mesh in this list
- 2) if not: => CAS\_FIGURE=' 3D'
  - if there exists at least 1 2D mesh in this list
    - if the geometry is "2D" => CAS\_FIGURE=' 2D'
    - if the geometry is "3D" => CAS\_FIGURE=' 2.5D'
  - if not: => CAS\_FIGURE=' 1.5D'
    - if there exists at least 1 1D mesh in this list

## 3.10 Operands TRANSF\_GEOM\_1 and TRANSF\_GEOM\_2

the 2 key keys TRANSF\_GEOM\_1/2 =  $(fx, fy, [fz])$  make it possible to carry out one (or two) geometrical transformations on cordonnées of the nodes of meshes 1 and 2 before making projection. This geometrical transformation is temporary (the time of the phase of pairing): the meshes are not modified

In 2D for example, the 2 functions (or formulas)  $fx, fy$  are functions of  $(X, Y)$  which will be applied to compute: the 2 new coordinates of the nodes:  $fx$  to compute: the new one  $X$  and  $fy$  to compute: the new one  $Y$ .

The applications aimed by these keywords are for example:

1. Projection of a mesh (given in mm) on another mesh (given in m). The geometrical transformation (TRANSF\_GEOM\_2) is a homothety of ratio 1000.
2. Projection of a thermal computation makes on a model 2D axisymmetric on a model 3D (but axisymmetric!). The geometrical transformation (TRANSF\_GEOM\_2) is then that which "3D crushes" solid in a meridian half-plane:

Let us suppose that the mesh 3D is a solid of axis  $Oz$ , the functions  $fx, fy, fz$  required are:

$$fx = \sqrt{(x^2 + y^2)} \quad fy = z \quad fz = 0.$$

An example of use of key word TRANSF\_GEOM\_2 is given in the case test zzzz110a

In general, TRANSF\_GEOM\_2 is sufficient, but it can be convenient to combine the two transformations to pass by a simpler intermediate geometry. If for example, one wants to project one result calculated on an air cooler of geometry (A) towards another slightly different geometry (B), it can be simpler

to break up the geometrical transformation via an intermediate cylinder.

## 3.11 Operand CARA\_ELEM

This operand is compulsory for method SOUS\_POINT and prohibited for the others. It makes it possible to inform the cara\_elem OBJECT related to THE MODELE\_2 in order to take into account all information related to the subpoints and necessary to projection .

## 3.12 Selection of the names of the fields

the key keys TOUT\_CHAMP = "OUI" or NOM\_CHAM = 1\_noch make it possible to choose which are the fields of the SD RESULTAT which one wants to project (by default all fields at nodes). One can also project the fields by elements" ELNO "and" ELEM "; for that, it is explicitly necessary to give their names via key word NOM\_CHAM .

## 3.13 Remarks on the projection of the fields by elements for method "COLLOCATION"

This possibility was introduced initially to make it possible to project the fields of pressure calculated by the Code Saturn (constant by elements) on the skin of a mechanical mesh Aster. This development being general, it is available for all fields "ELEM" and "ELNO" but result of projection is sometimes a little diverting.

As for the fields at nodes, the fields by projected elements of the concept evol in the concept resu will bear the same names (for example: "SIGM\_ELNO").

The projected fields (resu) will be "natural" by default in the same way as the fields "origin" (evol): "ELEM" or "ELNO".

One can however modify this behavior by default by means of key word TYPE\_CHAM=' NOEU' to force the fields projected to be fields at nodes.

What does one make numerically?

- Fields of the type ELNO : for each mesh of mesh 2, one traverses the nodes of this mesh and one calculates the value of each node as one would do it for a field at nodes. Result of this projection is thus (by construction), a field ELNO which is **continuous** between the elements whereas the initial field is not it.
- So moreover, meshes 1 and 2 have common nodes (for example, the projection of a quadratic mesh on a linear mesh), then the value projected on a node ( $N_2$ ) of mesh 2 has an unforeseeable side: the value carried by the node  $N_2$  will be that carried by the equivalent node of mesh 1 in one **of meshes** sharing this node. But the choice of this mesh is arbitrary. Fields of the type ELEM (constant by mesh): the value carried by a mesh of mesh 2 is obtained by arithmetic mean of the values carried by its nodes (calculated as for a field ELNO).

When TYPE\_CHAM=' NOEU' is not used, the projection of fields by elements has meaning only if the elements projected the ones on the others are in the same way "standard" (shell, beam, isoparametric). Indeed, if one 3D projected for example a field "SIGM\_ELNO" on a formed linear model by elements of bar, one could not store the values of stresses SIXX,... on these elements (which know only the generalized forces:  $N, MX, \dots$ )

### 3.13.1 Operand TYPE\_CHAM= `NOEU`

This key word is used to force the fields projected to be fields "with the nodes". This key word is systematically used (for example) by the command MACR\_LIGN\_COUPE because one cannot the model create fields by elements on "fictitious" of beam created by this macro-command of visualization.

**Note:**

When `TYPE_CHAM='NOEU'` is specified, the initial field is transformed into field at nodes before being project. The value of a node is the arithmetic mean of the values carried by the elements connected to this node. This average is made without taking account of key word `VIS_A_VIS`.

## 3.13.2 Projection of a discontinuous field ELNO

Problem:.

That is to say a formed structure by two zones  $A$  and  $B$  having a common border.

This structure is modelled twice  $MO1$  and  $MO2$ . These 2 models correspond to 2 different meshes  $MA1$  and  $MA2$ .

Also let us suppose that the meshes respect the border between the zones  $A$  and  $B$ , i.e. that there exists in each mesh two `GROUP_MA` ( $A$  and  $B$ ) corresponding to the zones  $A$  and  $B$ .

That is to say a field by elements "ELNO" (for example "HYDR\_ELNO") known on  $MO1$ . One wants to project it on  $MO2$ .

How to make so that the values of the field on  $A$  (respectively  $B$ ) is projected on  $A$  (respectively  $B$ )?

One wants to prevent that the values of  $A$  "do not pollute" the zone  $B$  and reciprocally.

This situation can occur as soon as there exists an important discontinuity of the field on the border enters  $A$  and  $B$ .

Response:

One cannot solve this problem with only one call to `PROJ_CHAMP`.

Indeed, the only method to project a field ELNO is method "COLLOCATION". This method is based on the localization of the nodes of mesh  $MA2$  in meshes of mesh  $MA1$ .

The geometrical phase of pairing of method "COLLOCATION" leads to the construction of a data structure making it possible to answer question:

- For is a node  $N2$  of  $MA2$ , in which mesh  $MA1$  of  $MA1$  this node and which is its position in this mesh?

For the nodes of the border enters  $A$  and  $B$ , there is only one possible response: either the node is associated with a mesh of  $A$  or it is associated with a mesh of  $B$ .

In general, association is unforeseeable by the user.

It can impose that all the nodes of the border are associated with  $A$  (or with  $B$ ) by means of key mode `VIS_A_VIS`, but that will not solve the initial problem. Indeed, if it imposes for example, that the nodes are associated with the zone  $A$ , values of  $A$  "will pollute" meshes  $B$  on the elements which touch the border.

By means of `can VIS_A_VIS`, it only choose "Which pollutes which?"

In short, method "COLLOCATION" is made to project continuous-current fields and it will be always unable to project easily and correctly a strongly discontinuous field.

Solution of skirting:

To solve the problem posed, it is necessary to use 2 times `PROJ_CHAMP` to project the zones independently  $A$  and  $B$ .

One obtains 2 fields  $CHA$  and  $CHB$  which it is then necessary to assemble with command `CREA_CHAMP/OPERATION='ASSE'`.

This "solution" is illustrated in the test `zzzz304a`.

## 3.14 Operand `DISTANCE_MAX`

to project the mesh `MA1` on the mesh `MA2`, the method (`COLLOCATION`) seeks in which element of the mesh `MA1` is each node of `MA2`, then interpolates the value using the shape functions of the element. When that a node of `MA2` is not in any element of the mesh `MA1`, the method connects the node and the point (of edge) of the element nearest. It interpolates the value using the shape functions of the element and that even if the node is "far" from this element.

If it be wished that a node which is not in any the elements of the mesh `MA1`, is not concerned with projection, one uses operand `DISTANCE_MAX`. This operand makes it possible to give the maximum distance which one authorizes between the node and the element nearest.

If the node does not answer the criterion of proximity the field will not be project on this node (i.e the node will not carry any component). There

is no default value for `DISTANCE_MAX`. What wants to say that by default, the field will be prolonged apart from the matter also far one will need it. Operand

## 3.15 `ALARME = "OUI" / "NON"` When

a node of the mesh "2" is found "far" from the elements of the mesh "1" (outdistances node with the mesh nearest of the mesh "1" higher than 10% to the diameter of this mesh), the code transmits an alarm message (`CALCULEL5_48`). One can avoid these alarms by means of `ALARME = 'NON'`.  
Operand

## 3.16 `PROL_ZERO = "NON" / "OUI"` For

the fields at nodes: •

When the user wants to impose a classification on the fields of `SD_RESULTAT`, it must use key words `NUMERICAL_DDL`. •

If desired classification imposes that a given node carries of the components and that the criterion of `DISTANCE_MAX` makes that this node is not concerned with projection, one is unable to affect values on this node. There will be, by default, a fatal error in this case. To avoid this fatal error, the user must use key word `PROL_ZERO = 'OUI'` in order to affect value 0. on this node.  
For

the fields with the elements: •

Key word `PROL_ZERO` can also be used during the projection of the fields by elements. It has the same meaning: one assigns the field to "zero" where projection could not be made.  
`NUMERICAL`

## 3.17 operand `DDL = nu` This

key word makes it possible "to number" the fields projected (for a data structure of type "mode") according to (nu) classification. It is necessary if one wishes to use result of the command in later computations (commands `REST_GENE_PHYS`, `PROJ_BASE`, ...). Selection

## 3.18 of the sequence numbers cf

[U4.71.00]. Operand

## 3.19 `NOM_PARA NOM_PARA`

= will lpara, This

key word is followed of a list of names of parameters of `SD_RESULTAT` evo 1. The parameters of evo 1 corresponding to these names will be recopied in data structure produced by the command (resu). Example:

during the projection of eigen modes, one can indicate: `NOM`

```
_PARA= ("AMOR_REDUIT", "MASS_GENE") Operand
```

## 3.20 TITER TITER

= titr, Title  
which one wants to give to the result concept. Example

## 4 Computations

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thermal and mechanics on two different meshes. my

```
1=LIRE_MALLAGE (...) ; Mo
1=AFFE_MODELE (MALLAGE=ma1, AFFE
              =_F (TOUT=' OUI', PHENOMENE=' THERMIQUE',...)); ...
evo
1= THER_LINEAIRE (= mo1 MODELS,... ); my

2= LIRE_MALLAGE (...) ; # mesh      more refined Mo
2= AFFE_MODELE (MALLAGE=  ma2,..., PHENOMENE=' MECANIQUE',...); evo

2= PROJ_CHAMP (METHODE=      "COLLOCATION", RESULTAT = evo1, NOM
              _CHAM= "TEMP", _
              1= mo1 MODELS, MODELS      _2= mo2,);  chmat

2 = AFFE_MATERIAU (... , AFFE_VARC=_F (NOM_VARC=' TEMP', EVOL= evo2,...))
```