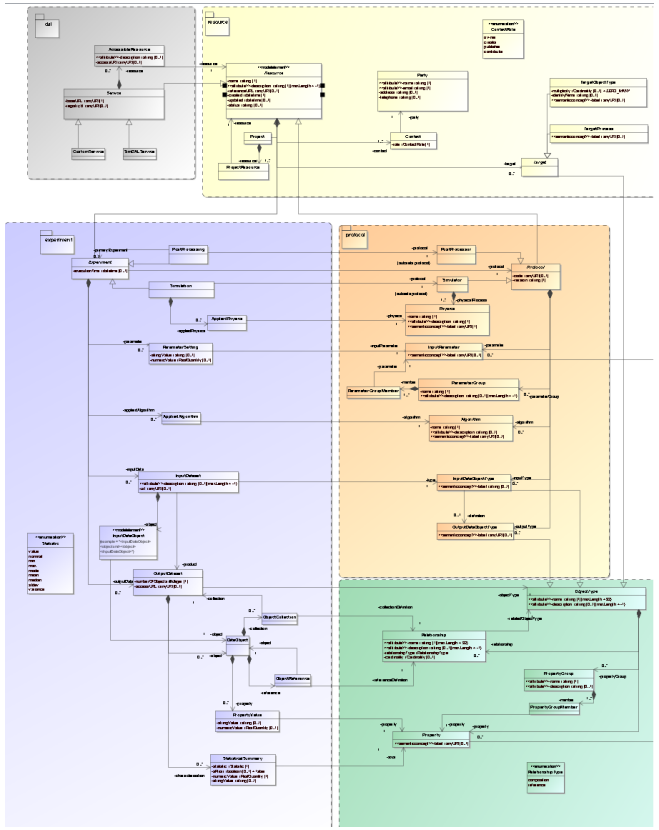
Theory Interest Group at IVOA

20:30 UTC 4 November 2021

Chair: Gerard Lemson

Vice-chair: Simon O'Toole

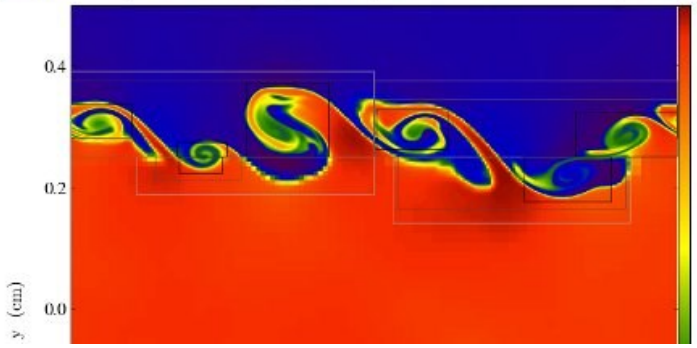


```
                data["x-velocity"][1:-1,1:-1,sl_left]) \
                / (div_fac*data["dz"].flat[0])
        dvzdx = (data["z-velocity"][sl_right,1:-1,1:-1] -
                data["z-velocity"][sl_left,1:-1,1:-1]) \
                / (div_fac*data["dx"].flat[0])
        new_field[1:-1,1:-1,1:-1] += (dvxdz - dvzdx)**2.0
        del dvxdz, dvzdx

    new_field = np.abs(new_field)**0.5
    return new_field
add_field("AbsVorticity", function=_AbsVorticity,
          validators=[ValidateSpatial(1,
              ["x-velocity","y-velocity","z-velocity"])],
          units=r"\rm{s}^{-1}", take_log=False)
```

```
In [7]: p = SlicePlot(pf, "z", "Density")
        p.annotate_grids()
        p.show()
```

```
yt : [INFO     ] 2013-09-11 22:10:24,364 xlim = 0.000000 1.000000
yt : [INFO     ] 2013-09-11 22:10:24,365 ylim = 0.000000 1.000000
yt : [INFO     ] 2013-09-11 22:10:24,365 Making a fixed resolution buffer of (Density) 80
yt : [INFO     ] 2013-09-11 22:10:24,384 xlim = 0.000000 1.000000
yt : [INFO     ] 2013-09-11 22:10:24,384 ylim = 0.000000 1.000000
yt : [INFO     ] 2013-09-11 22:10:24,385 Making a fixed resolution buffer of (Density) 80
yt : [INFO     ] 2013-09-11 22:10:24,406 Making a fixed resolution buffer of (Density) 80
```



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3.3.1.5 : MPAHalo

The table stores all the halos from the milli-Millennium simulation in a representation that allows efficient querying for merger histories. For description how these merger trees were constructed see Springel2005a and DeLucia2006b.

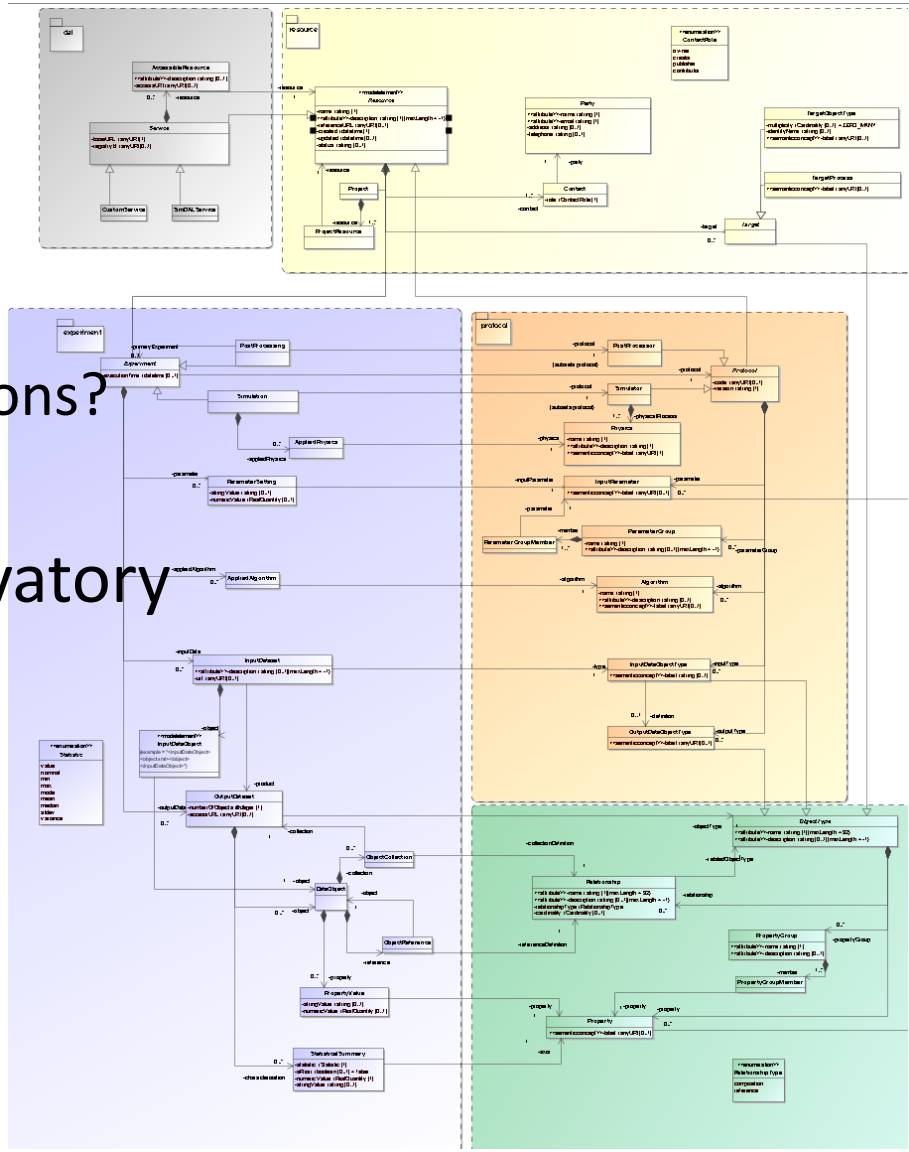
column	type	UCD	unit	description
haloID	long	meta.id;meta.main		The id of this halo, unique within the full simulation.
subHaloID	long	meta.id;		The id of the sub-halo corresponding to this halo.
lastProgenitorId	long	meta.id;assoc		Indicator of the last progenitor in the halo merger tree rooted in this halo. All halos with id between haloId and lastProgenitorId form the merger tree rooted in this halo. Foreign key to MHHalo.haloId.
treeId	long	meta.id;parent		The unique id of the galaxy formation "tree" to which this halo belongs.
snapNum	int	time		The snapshot number where this halo was identified. This column corresponds to the snapnum column in the Snapshots table in this database.
redshift	float	time		The redshift of the snapshot to which this halo belongs.
firstProgenitorId	long	meta.id;assoc		The id of the main progenitor of this halo. Strictly, haloId+1 iff lastProgenitorId > haloId, else -1.
nextProgenitorId	long	meta.id;assoc		The ID of the "next progenitor" in a linked list representation of the halo merger trees.
descendantId	long	meta.id;assoc		The haloId of the descendant f this halo in the merger tree. -1 if there is no descendant.
firstHaloInFOFgroupId	long	meta.id;assoc		Id of the halo at the center of the friend-of-friends group to which this halo belongs.
nextHaloInFOFgroupId	long	meta.id;assoc		Id of the "next halo" in the linked list representation of the friend-of-friends grouping.
np	int	meta.number		Number of simulation particles in this halo.
m_Mean200	float	phys.mass	10^{10} Msun/h	The mass within the radius where the halo has an overdensity 200 times the mean density of the simulation. NB this value is only defined for halos with haloId=firstHaloInFOFgroupId.
m_Crit200	float	phys.mass	10^{10} Msun/h	The mass within the radius where the halo has an overdensity 200 times the critical density of the simulation. NB this value is only defined for halos with haloId=firstHaloInFOFgroupId.
m_TopHat	float	phys.mass	10^{10} Msun/h	The mass within the radius where the halo has an overdensity corresponding to the value at virialisation in the top-hat collapse model for this cosmology. NB this value is only defined for halos with haloId=firstHaloInFOFgroupId.
phKey	int			The Peano-Hilbert index for the position of this halo. See the text on spatial indexes.
x	float	pos.cartesian.x	Mpc/h	The X-coordinate of the position in comoving coordinates.
y	float	pos.cartesian.y	Mpc/h	The Y-coordinate of the position in comoving coordinates.
z	float	pos.cartesian.z	Mpc/h	The Z-coordinate of the position in comoving coordinates.
zIndex	long			The "bit-interleaved" or "Z-curve" index, same resolution as phKey. See the text on spatial indexes.
ix	integer	pos.cartesian.x		Zone index along x-direction, based on 7 bins See the text on spatial indexes.
iy	integer	pos.cartesian.x		Zone index along y-direction, based on 7 bins See the text on spatial indexes.
iz	integer	pos.cartesian.x		Zone index along z-direction, based on 7 bins See the text on spatial indexes.
velX	float	phys.veloc	km/sec	The X-component of the peculiar velocity.
velY	float	phys.veloc	km/sec	The Y-component of the peculiar velocity.
velZ	float	phys.veloc	km/sec	The Z-component of the peculiar velocity.
velDisp	float	phys.veloc.dispersion	km/sec	he velocity dispersion of the halo.
vMax	float	phys.veloc.rotat	km/sec	Maximum rotational velocity, calculates as the maximum of the expression sqrt(G M(r)/r) where r runs of the particles in the halo.
spinX	float	phys.veloc.ang	(Mpc/h) (km/sec)	The X-component of the spin of the halo.
spinY	float	phys.veloc.ang	(Mpc/h) (km/sec)	The Y-component of the spin of the halo.
spinZ	float	phys.veloc.ang	(Mpc/h) (km/sec)	The Z-component of the spin of the halo.
mostBoundID	long	meta.id;assoc		The id of the most bound particle of this halo.
fileNr	int	meta.file;meta.id		Original file number in which the subhalo was defined.
subhaloIndex	int	meta.id;assoc		Index of this subhalo in the file identified by fileNr.
halfmassRadius	float	phys.size.radius	Mpc/h	Radius containing half of the mass of the halo.
random	integer			Random number between 0 and 1000 (using java.lang.Math.random()).

Discussion items

1. Implementations of SimDM (and SimDB)
2. Standard libraries for accessing *cosmological simulations* on science platforms
    1. Matt: The yt library and others
3. Data model for products of *cosmological simulations*

SimDM implementations (& SimDB)

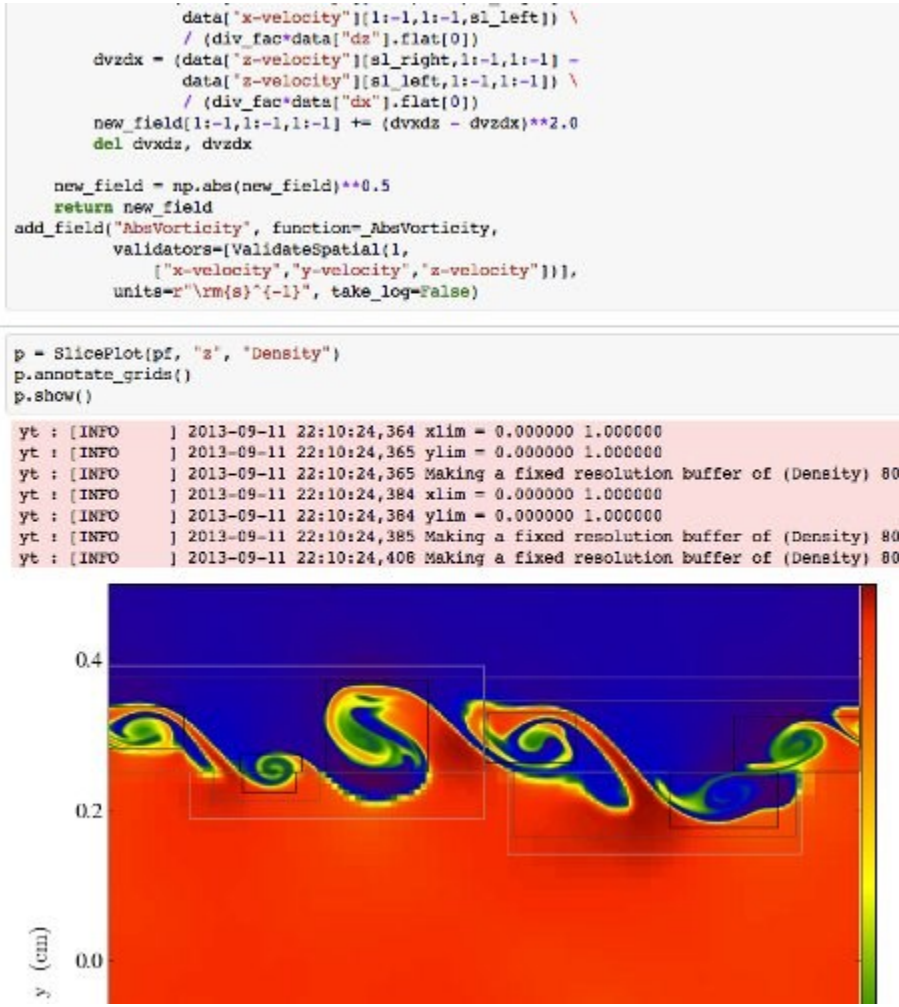
- Data model since 2012
  - https://ivoa.net/documents/SimDM/20120503/index.html
  - Version 1.1
    VO-DML version available, not yet pushed Implementations?
  - Proof-of-concept based on VO-URP (L. Bourges, GL)
- Franck: Implementation experiences at Paris Observatory



Standard libraries for accessing cosmological simulations

(on science platforms)

- I/O libraries providing standard-like data structures for common simulation types: nbody, SPH, (adaptive) meshes, …
  - See discussion 3
- Examples of such codes:
  - Matt on yt



Standard *data* model for cosmological simulations

- E.g. for N-Body particles (raw), clusters/halos (post), mesh cells (raw)
  - snapshots vs individual timestampe-ed orbits vs …
- Chris: experiences at CCA, Flathub

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random	integer			Random number between 0 and 1000 (using java.lang.Math.random()). See the page on random sampling.

Conclusions

0. upgrade SimDM->v1.1. Including VO-DML representation
   new DM+Theory effort. With Franck, Herve, GL etal
1. Implementations of SimDM (and SimDB)
    1. Obs Paris group willing to share their code.
    2. Paul Harrison interested to try out his code generation formalism on SimDM v1.1 in VO-DML
    3. Simon interested in implementations, possibly open to “all”
2. Standard libraries for accessing *cosmological simulations* (on science platforms) *informed by*
3. Data model for products of *cosmological simulations*

Further discussions on slack and mailing list