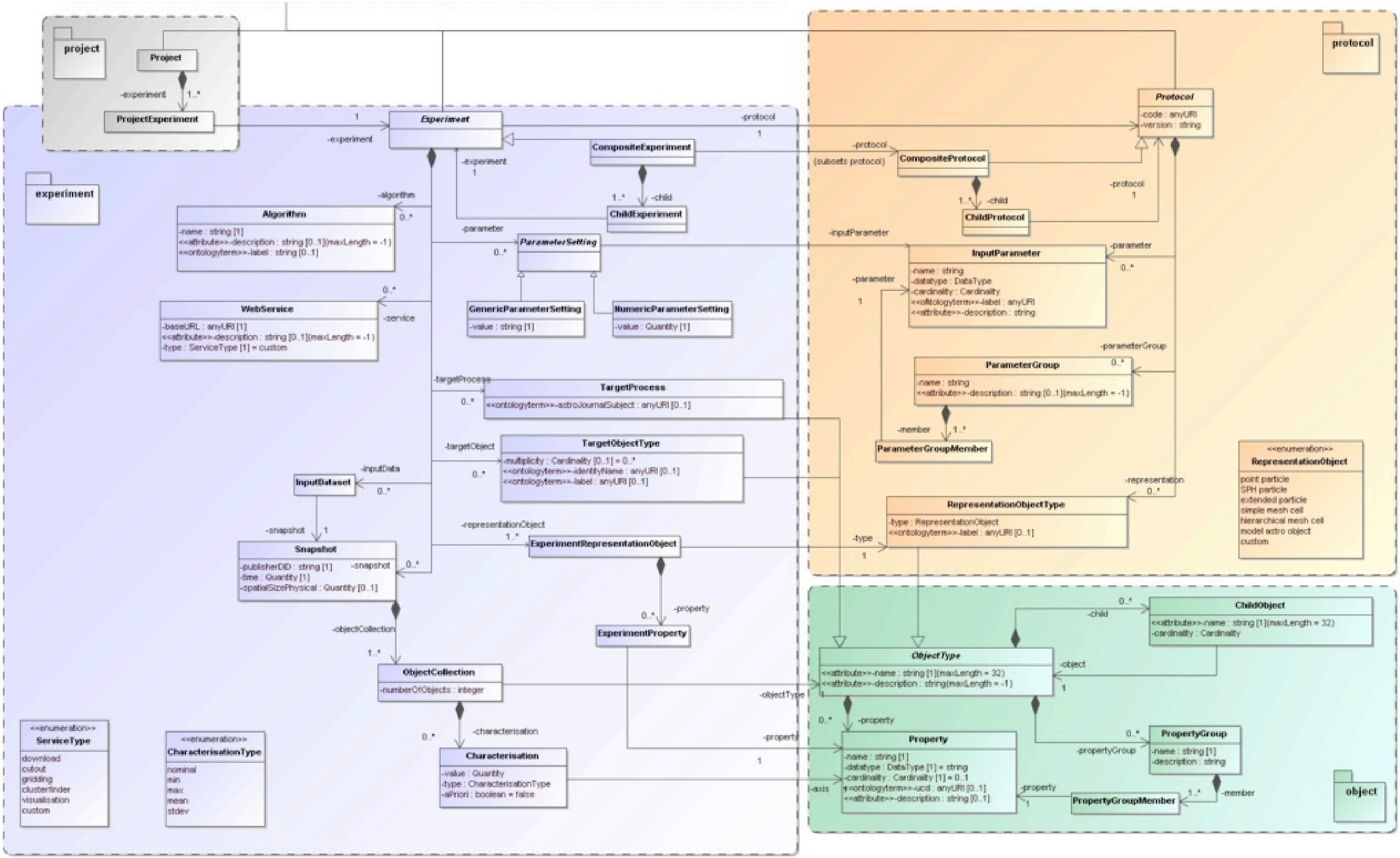
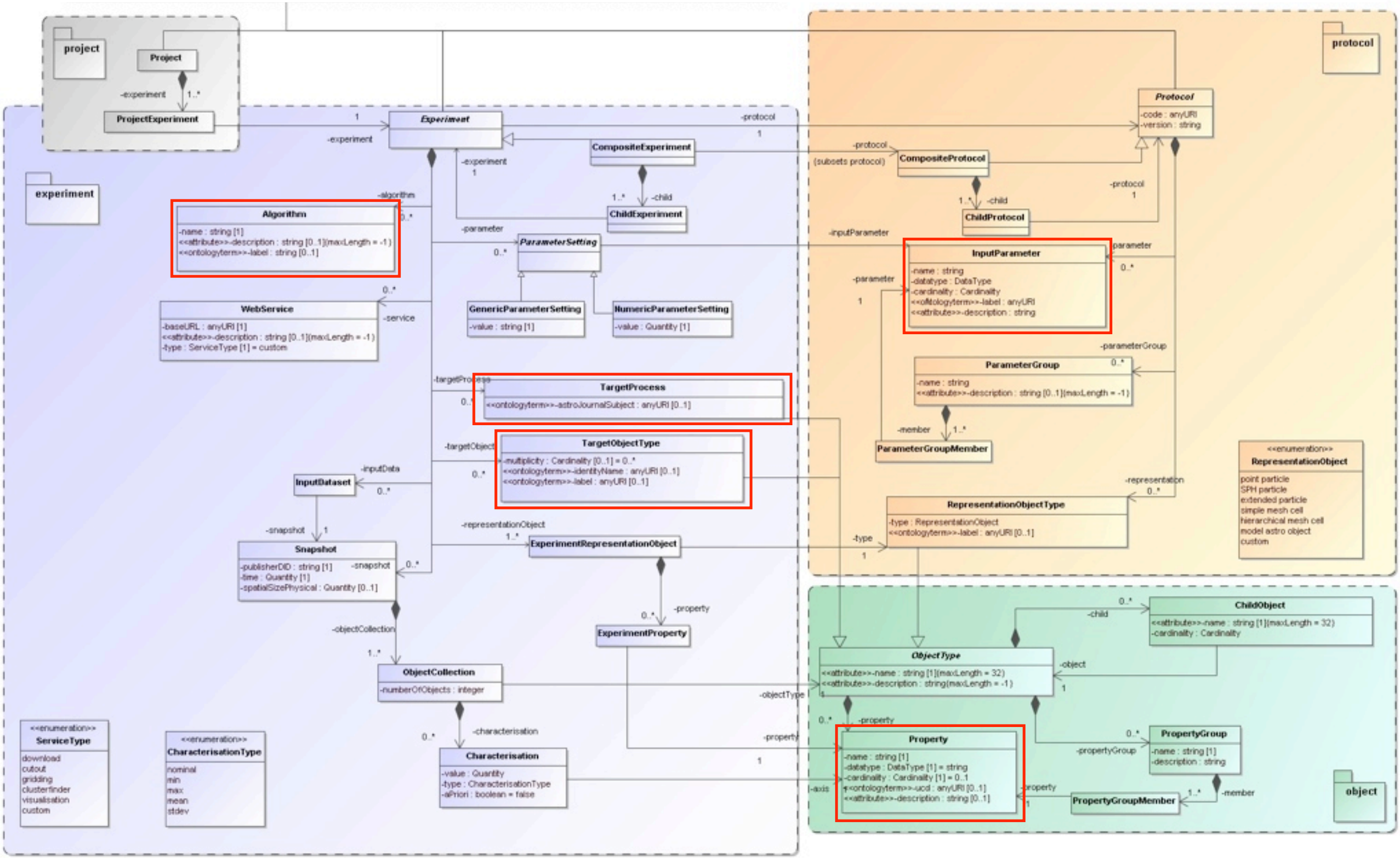
Semantics for Theory

Franck Le Petit

SimDB datamodel



Registration and discovery of simulations



Semantics is required for classes

RepresentationObjectType	**Category of Astro-Object**
Example: Large structure, galaxy, chocs, jets, nebula, ...	
Property	**Physical quantity**
Example: Temperature, Velocity, Position,	
TargetProcess	
Example: Turbulence, gravitationnal cluster, galaxy formation, ...	
IdentityName	**Name of an astronomical objects**
Example: M31, NGC 402, ...	
Algorithms	
Example:	
InputParameter	**Physical quantity / Algorithm parameters**
Example: Cosmological parameters, number of particles, mesh size, ...	
Physics	**Physical processes**
Example: Gravitation, MHD, Radiative transfer, ...	

Semantics required for:

- **Astrophysical Objects:** Ex: Galaxy, disk, bulk, Cloud, gas, jets, baryonic matter, ...
- **Physical quantities:** Ex: Velocity, Temperature, Temperature of electrons, ...
- **Physical processes** Ex: Gravitation, MHD, hydrodynamics, Radiative transfer
- **Algorithms** Ex: Tree, SPH, Vlasov solver, Monte Carlo,
- **Algorithms parameters** Ex: number of cells, binning factor, ...
- **IdentityName** Ex: M31, ...

Preliminary list of keywords for Theory done in:

- **Victoria:** based on A&A keywords
- **Paris - Summer 2007**

Mainly based on A&A keywords
And our own list

In the mean time, major works done by the **Semantic Working group**

- **Ontology of Astronomical Objects**

- **Vocabularies => IVOA Thesaurus**
  - A&A keywords
  - AOIM
  - UCD
  - IAU 93 thesaurus

- UCDs

- IVOAT

Vocabularies in the Virtual Observatory
Version 1.0

IVOA Working Draft, 2008 March 20

This version
http://www.ivoa.net/Documents/WD/Semantics/vocabularies-20080320.html
Latest version
http://www.ivoa.net/Documents/latest/vocabularies.html
and issues list
Working Group
Semantics
Editors
Alasdair J G Gray, Norman Gray, Frederic V Hessman and Andrea Preite Martinez
Authors
Sébastien Derriere, Alasdair J G Gray, Norman Gray, Frederic V Hessman, Tony Linde, Andrea Preite Martinez, Rob Seaman and Brian Thomas

The IVOAT (based on IAU93 thesaurus) is pretty complete and seems to fullfill several needs of Theory I.G.

Semantic for Physics / Physical process

IAU93 contains many physical processes
- still a need to add processes

Keyword	A&A vocabulary	IAU93 vocabulary
Absorption		#Absorption
Acceleration of particles	#AccelerationOfParticles	#ParticleAccretion
Accretion	#Accretion	
Astrochemistry	#Astrochemistry	#astrochemistry
Advection		
Atomic Processes	#AtomicProcesses	#AtomicProcesses
Bremsstrahlung		#Bremsstrahlung
Chaos	#Chaos	None
Collision		#Collisions
Collisional excitation		#CollisionalExcitation
Collisional plasma		*#CollisionalPlasmas*
Collisional broadening		#CollisionBroadening
Collisonal processes		#CollisionProcesses
Compton effect		#ComptonEffect
Compton scattering		*#ComptonScattering*
Conduction	#Conduction	#Conduction
Convection	#Convection	#Convection
		#CosmicElectrodynamics
Cosmochemistry / Primordial chemistry		#Cosmochemistry
Diffusion / Scattering	#Diffusion / #Scattering	#Diffusion / #Scattering
		#EnergyTransfer
Electrodynamics		#Electrodynamics
Equation of state	#EquationOfState	
Fluorescence		#Fluorescence
Gravitation	#Gravitation	#Gravitation
Hydrodynamics	#Hydrodynamics	#Hydrodynamics
Inverse Compton scattering		#InverseComptonScattering
Line broadening		#LineBroadening

Keyword	A&A vocabulary	IAU93 vocabulary
Magnetohydrodynamics	MHD	#Magnetohydrodynamics
MHD Hall		
Mie scattering		#MieScattering
Molecular processes		#MolecularProcesses
		#NewtonianGravitation
		#MolecularBands
Nuclear reaction		#NuclearReaction
		#Nucleosynthesis
Photoelectric effect		
Photoionization		#Photodissociation
Photodissociation		#Photoionization
Plasma physics		#PlasmaPhysics
Polarization	#Polarization	#Many narrower
Radiative transfer		#RadiativeTransfer
		#RadiativeBraking
		#RadiationScattering
		#radiativeCapture
		#RadiativeEquilibrium
		#RadiativeRecombination
		#RamanScattering
		#RayleighScattering
Surface reactions		
		#Reddening
Scattering / diffusion		#Scattering
Sunyaev-Zeldovitch effect		
Synchrotron radiation		#SynchrotronRadiation
		#ThermalConductivity
		#ThomsonScattering
Turbulence	#Turbulence	

"Theory" related quantities

Parameters can be a difficulty

Some of them are in the IVOAT

Examples on some parameters and Physical quantities:

- Omega Parameter
- Lambda Parameter
- Hubble constant
- Gas to dust ratio
- ISRF scalling factor (missing in vocabulary)
- Cosmic ioinization rate
- ... But list can be pretty long and are community dependent

Some of them can be used as column name in VO-Table.

- Should they be declared as UCD or not ?
  Or only with a "param" UCD ?

- Should we introduce the missing ones in the IVOAT thesaurus

- Should we include them in a "Theory vocabulary" ?

Sometimes need for precise concepts

- Temperature
  - Ion temperature
  - Electron temperature
  - Effective temperature
  - *Excitation temperature (missing)*

Semantics required for:

- **Astrophysical Objects:** Ex: Galaxy, disk, bulk, Cloud, gas, jets, ...
- **Physical quantities:** Ex: Velocity, Temperature, Temperature of electrons, ...
- **Physical processes** Ex: Gravitation, MHD, hydrodynamics, Radiative transfer
- **Algorithms** Ex: Tree, SPH, Vlasov solver, Monte Carlo,
- **Algorithms parameters** Ex: number of cells, binning factor, ...
- **IdentityName** Ex: M31, ...

Semantics for Algorithms / Algorithms parameters

Cosmo / Hydro / MHD

- Nbody (same than particle-particle ?)
- mesh
- tree
- particle-particle
- particle-grid = PM
- adaptive mesh refinements : AMR (?)
- adaptive tree refinements (?)
- collisionless (?)
- smooth particle hydrodynamics = SPH
- tree - sph
- fast-multipole method
- piecewise parabolic method
- piecewise linear method
- isochrone synthesis
- Fuel consumption theorem
- leap frog
- individual timestep
- static
- adaptative timesteps
- symplectic integrator

Plasma

- Fokker-Planck solver
- Vlasov solver
- PIC /PIC delta f
- Test-particle

Numerical Relativity

- Spectral methods
- Multi-domain spectral methods
- 3+1 formalism
- harmonic coordinates
- iterative system solver - Krylov solver
- finite difference (? too general)

Radiative transfer

- ALI
- CEP
- Monte Carlo
- LVG
- Escape probability
- LTE
- Zeeman-Feautrier
- Orthogonal polynomial expansion
- Other

Integrator

- leap frog
- Individual time step
- Static
- Adaptive time steps
- Runge-kutta
- integrator

Semantics for Algorithms / Algorithms parameters

Algorithms parameters
- box size
- binning factor
- number of cell
- resolution
- ...

Need for a vocabulary of concepts concerning Algorithms and algorithms parameters

- Preliminary effort done by Theory I.G.
- Use SKOS/RDF ?
- How to develop it ?
  - How to motivate people of different communities to develop this vocabulary.
  - Need to build it progressively
- How to maintain it ?
  - Twiki and moderators ?

Discussions:

AstroObjects, Physical processes, Physical parameters

- Suggestion: VO-Theory I.G. starts with the concepts in IVOAT

How to introduce the new concepts
- Physical parameters may produce a large list

Algorithms and algorithms parameters

- Suggestion: The VO-Theory I. G. build a SKOS vocabulary
- How to develop efficiently such vocabulary ?
- How to maintain them ?

IndentyName

How to define IndentyName ?

Usecase:
Find all simulations producing I.R. spectra of TMC 1