FRANCO VAZZA

CURRICULUM VITAE

Personal Data:

Born: Vittorio Veneto (TV) 19/09/1979

Nationality: Italian

Present Position: Post-Doc at the Radio Astronomy Institute of Bologna (until July 2010).

Present Address: Istituto di Radioastronomia, via P. Gobetti 101, 40129 Bologna, Italy

Phone: +39 051 6399383 +39 340 5854782 (mobile)

Formation:

2004: Degree in Astronomy at the University of Padova (Discussion in date 22/07/2004; mark 105/100), supervisor Prof. G.Tormen

2006/2008: PhD at the Astronomy Department at Bologna, winner of the INAF grant at the Radio Astronomy Institute of Bologna, supervisors Prof.G.Setti an Dott.G.Brunetti.

2008: Marco Polo grant from University of Bologna, for 3 months visit at CASS institute in S.Diego (California-USA)

2009: Discussion and approval of PhD Thesis (07/04/2009).

2009-till present: Post-Doc at the IRA (conclusion July 2010).

Fellowships, Awards Grants

2006: visiting PhD student at Astronomy Department, University of Daejeon (South Korea)

2007: visiting PhD student at Max Planck Institute for Astrophysics, Garching (Germany)

2008: visiting PhD student at Center for Astrophysics and Space Science, San Diego-CA (USA)

2008: visiting PhD student at Center for Astrophysics, Cambridge-MA (USA)

2008: visiting PhD student at Max Planck Institute for Astrophysics, Garching (Germany)

2009: award for best contribution at “Cosmological Magnetic Field” Conference (31.05-5.06, Ascona, organized by ETH).

2010: winner of a “Taux3” grant from French Government and Scientific Bureau of French Embassy in Italy

Computing Proposals:

Assigned computation time at CINECA Supercomputing Center (Bologna)

2004 : 20 000 allotted CPU hours on SP4

2005: 40 000 allotted CPU hours on SP4/SP5

2006: 40 000 allotted CPU hours on SP5/CLX

2007: 30 000 allotted CPU hours on SP5

2008: 70 000 allotted CPU hours on SP5/BCX

2009: 400 000 allotted CPU hours on SP6 (winner of Italian National Key Project).

Oral contribution at Conferences and Workshops

2006 KASI-APCTP Joint Workshop: ”Origin, Propagation and Interaction of Energetic Particles” 17-19 May, Daejon, South Korea

2007 ”X-RAY Surveys: Evolution of accretion, star formation and large scale structures”, Rodos island (Greece), July 02 - July 06

2007 XXXVII Young European Radio Astronomers Conference 4-7 September, Bordeaux, France

2008 ”Turbulence and Dynamos” from 17 March to 21 March, Nordita, Stockholm, Sweden

2008 ”Computational Astrophysics in Italy: results and perspectives”, Rome - March 12, 2008

2009 “Cosmological Magnetic Fields”, 31.05-05.06, Ascona, Switzerland.

2009 “Shock Waves, Turbulence and Particle Acceleration 18.11-21.11, Pohang, South Korea

2010 “Magnetic fields on scales kiloparsecs to kilometres: properties and origin conference.” Crakow, Poland

LIST OF PUBLICATIONS

Dolag K., **Vazza F.**, Brunetti G., Tormen G., 2005, MNRAS, 364, 753 “Turbulent gas motions in galaxy cluster simulations: the role of smoothed particle hydrodynamics viscosity”

Vazza F., Tormen G., Cassano R., Brunetti G., Dolag K., 2006, MNRAS, 369, L14 “Turbulent velocity fields in smoothed particle hydrodymanics simulated galaxy clusters: scaling laws for the turbulent energy “

Vazza F., Brunetti G., Gheller C., 2009, MSAIS, 13, 151 “Cosmological shocks in Eulerian simulations: main properties and cosmic rays acceleration”

Vazza F., Brunetti G., Gheller C., 2009, MNRAS, 395, 1333 “Shock waves in Eulerian cosmological simulations: main properties and acceleration of cosmic rays”

Vazza F., Brunetti, G., Kritsuk, A., Wagner, R., Gheller, C., & Norman, M. 2009, A&A, 504, 33 Highlight of A& A “Turbulent motions and shocks waves in galaxy clusters simulated with adaptive mesh refinement”

Vazza F., Gheller, C., & Brunetti, G. 2010, , 513, A32 “The Mixing and Transport Properties of the Simulated ICM: a Study with Tracers”

Vazza F., Brunetti, G., Gheller, C., & Brunino, R. 2010, arXiv:1003.5658 “Massive and refined: a sample of large galaxy clusters simulated at high resolution. I: thermal gas and properties of shock waves.” NewAstronomy, in press

Additional Publications

- Master Thesis: “Turbulence in the ICM of simulated Galaxy Clusters” (2004)
  Download at http://dipastro.pd.astro.it/cosmo/franco/thesis_franco.html
- PhD Thesis: “Shocks and Turbulence in Simulated Large Scale Structures” (2009)
  Download at http://www.ira.inaf.it/∼ vazza/tesi_vazza.pdf

  Personal web page: http://www.ira.inaf.it/∼vazza

ADDITIONAL INFORMATION
RESEARCH INTERESTS

- **Shock Waves and Cosmic Rays Acceleration in Galaxy Clusters** : using as a reference tool the Eulerian cosmological code ENZO, I produced a large sample of cosmological runs for a large volume of the universe and several hundreds of galaxy clusters with appropriate mass and spatial resolution. I developed a dedicated scheme to characterize shock waves developing during Large Scale Structure formation processes and to measure in an accurate way their Mach number and related energetics, studying the influence of numerical setups and modeled physics on the main quantity. I adopted standard recipes to associate Mach numbers with an efficiency in the acceleration of Cosmic Rays Hadrons via Fermi processes, and I studied the population of Cosmic Rays concentrated within

galaxy clusters and filaments. An extended comparison of this data to those present in literature was investigated, showing the high accuracy and the overall consistency of results with known upper limits as derived from existing Radio and Gamma observations. The main methods of the above analysis have been tested also with a smaller sample of cosmological numerical simulations produced by the Eulerian Code HYDROPAD, created by C.Gheller.The main results of this line of research were reported in:**Vazza, Brunetti & Gheller (2009) a,b; Vazza et al.(2009); Vazza et al.(2010).**

- **Turbulent Energy Support in Galaxy Clusters**: using as a reference the cosmological Smoothed Particle Hydrodynamics code GADGET (Springel, Yoshida & White 2001) a sample of high resolution numerical simulations of massive galaxy clusters has been analyzed, conceiving an original algorithm to disentangle chaotic motions from laminar ones. This allowed for extracting with high accuracy the onset of turbulent motions driven within the cluster plasma by the crossing of sub-clusters and by generated shock waves, and to follow their dependency on cluster evolutions over time. A recipe to join the information of cluster plasma turbulence to re-acceleration processes of mildly relativistic electrons via coupling with MHD waves has been investigated, confirming the plausibility of the 'Re-acceleration Scenario' as explanation of the origin of observed Radio Halos. Results of this line of research were reported in: **Dolag, Vazza et al.(2005) and Vazza et al.(2006).**

- **High resolution AMR simulations of Turbulence and Shock Waves in Galaxy Clusters**: the onset and further evolution during cosmic time of the turbulent motions following merger events was studied with an original implementation of Adaptive Mesh Refinement methods, which refines the number of cells where a new control variable (linked to the small scale variability of the velocity field) is adopted. This allows for increasing to an unprecedented level the spatial resolution achieved in the description of turbulent eddies and shock waves generated in very large volume numerical simulations. This method made possible to study in detail the evolution of the power spectrum of turbulent motions, which is so far an unexplored issue in cosmological numerical simulations. Results of this line of research were presented in: **Vazza et al.(2009 - Highlight of A&A for Vol.II Sept.09); Vazza et al.2010**.

- **Dynamics of Tracers Particles in the Intra Cluster Medium**: I build and tested an algorithm to track the propagation of mass-less particles which can be injected and advected at any time in the Eulerian representation provided by the ENZO code. This allows for increasing the range of studies which can be actually performed with high-resolution, Eulerian simulations with ENZO, and performing first exploratory investigations about the mixing properties of the ICM (i.e. transport processes of metals and Cosmic Rays) in a sample of massive galaxy clusters. The results of this line of research were presented in: **Vazza, Gheller & Brunetti (2010).**

- **Comparison of Cosmological Numerical Codes and Shocks Detecting Schemes**: I joined an international research group (which K.Dolag, D.Ryu, H.Kang, T.Jones, G.Brunetti, C.Gheller) studying the mutual convergence of three of the most used cosmological numerical codes (GADGET, ENZO and the ES-TVD code by D.Ryu). Using an identical cosmological setups of initial conditions for the three codes, the group produced a set of large scale simulations at several resolutions, studying in details dark matter properties and thermal properties for all simulations at present epoch. The overall level of consistency among codes is pretty good, on average of the order of 10 % for the most relevant statistics involved in our analysis (halos mass functions, halos baryon fractions, density and temperature distributions, etc). On the other hand, remarkably larger differences are measured from code to code in all measures more strictly depending on the particular accretion history of the simulated structures, such as entropy distributions and shocks occurency. Currently, I am Principal Investigator for the comparison of shock waves produced in the three codes of the project, and to their properties related to Cosmic Rays acceleration processes. In order to do this, the original detection scheme proposed by all authors are compared in details, and the regimes or convergency or disagreement are under investiagation. This research promises to be a major step forward for the community of simulators involved in Cosmic Rays acceleration processes using numerical simulations. The results of the comparison project are subject of a paper in preparation.