

Proposal for an ISSI Team

TITLE

Defining the full life-cycle of dwarf galaxy evolution: the Local Universe as a template

ABSTRACT

The origin and evolution of galaxies remain among the key unanswered questions in astrophysics. The galaxies we see within the Local Group are valuable representatives of the extragalactic population and have been evolving for the majority of cosmic time. As our nearest neighbors they can be studied in far more detail than their distant counterparts, and hence provide our best hope for understanding star formation and prototypical galaxy evolution (e.g., Freeman & Bland-Hawthorn 2002, Tolstoy, Hill & Tosi, 2009 Annual Review of Astronomy and Astrophysics, in press). Although significant observational progress has been made, we are still a long way from understanding the details. Accurate, large area, spatial, kinematical and chemical surveys of nearby stellar systems will provide the essential link with results from the high redshift Universe.

In spite of having received less attention than spiral and elliptical galaxies, dwarf galaxies have probably more significant cosmological relevance. They are the most diffuse type of systems in the Universe and the most sensitive to physical processes which are presumed to occur in all galaxies and lead to the evolutionary changes visible in galaxy samples over the history of the Universe. They are supposed to be the basic building blocks for the assembly of big galaxies in hierarchical Λ CDM models for structure formation predicting that hierarchical merging of dark matter haloes is the main driver in galaxy formation and evolution. Indeed the discovery of the tidally-disrupted Sagittarius dwarf (Ibata et al. 1994), one of the closest satellites of the Milky Way, provided the first compelling evidence of nearby merger phenomena. However, the detailed process by which galaxies arrive at their current state remains largely speculative. Understanding how dwarf galaxies evolve is therefore extremely important. The Local Universe provides us with a unique opportunity to study and model the detailed properties of a range of dwarf galaxy types – star by star.

To this aim, we have put together a team that combines complementary (spectroscopic, photometric, theoretical) expertises to attack this problem in the most comprehensive possible way. Our primary goal is to determine if there is an evolutionary link between early (dwarf spheroidals and ellipticals) and late dwarf galaxies (dwarf irregulars and blue compact dwarfs), and we plan to reach it by comparing detailed abundance determinations and star formation histories with detailed chemo-dynamical evolution models. Through these comparisons, we also plan to quantify the effect of galactic scale winds on the evolution of these small systems, and to determine how a starburst can occur and lead to runaway star formation in some of them.

As a by-product, this effort will also prepare the exploitation of future facilities both in space (e.g., JWST, GAIA) and on the ground (e.g., VLT/MUSE, Gemini/WFMOS on Subaru).

SCIENTIFIC RATIONALE

What is a dwarf galaxy ? Is there anything that really distinguishes it from bigger, more massive galaxies? Many galactic properties (e.g., potential well, metallicity, size) correlate with mass and luminosity, but all types of galaxies show rather continuous relations in structural, kinematic and population features between the biggest and the smallest of their kind (see Fig. 1). So, one cannot say that dwarfs are really special in any respect, and thus they can be used as sensitive probes of effects that are important in all galaxies. For example these small systems are much more sensitive to the feedback processes that result from star formation and also to the influence of environment. This makes them excellent places to study these kinds of effects. The conclusions can then be applied on all scales.

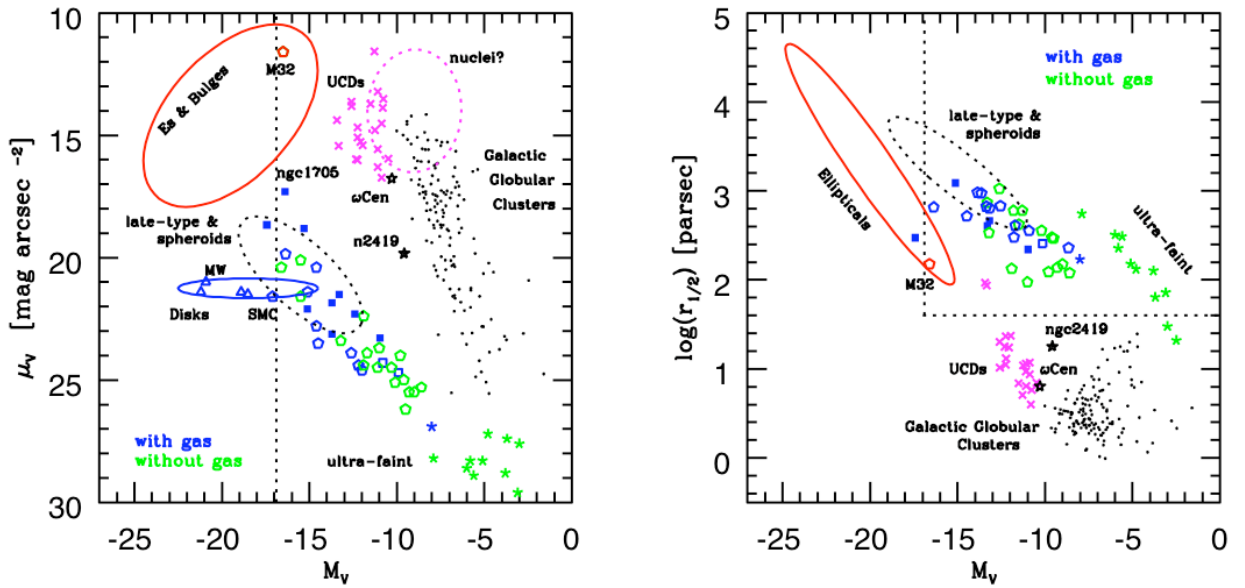


Figure 1: Here we display the structural properties of different types of galaxies compared with each other (after Kormendy 1985, Binggeli 1994), including as dashed lines the classical limits of the dwarf galaxy class as defined by Tammann (1994). In the left plot we show the absolute magnitude (M_V)-central surface brightness (μ_V) plane, and in the right the absolute magnitude (M_V)-half light radius ($r_{1/2}$) plane. Marked with coloured ellipses, are the typical locations of large galaxies as labeled. Peculiar globular clusters ω Cen and NGC2419 are marked close to the globular cluster ellipse; M32 in the region of Elliptical galaxies; the SMC on the border of the dwarf class. A sample of well studied Blue Compact Dwarfs (BCDs) are marked as blue solid squares. The Ultra-compact dwarfs (UCDs) studied in Virgo and Fornax clusters are marked with magenta crosses. Local Group dwarf galaxies are plotted as open pentagons, blue for systems with gas and green for systems without gas. The new ultra-faint dwarf galaxies found by Sloan are given star symbols, and the same colour code. For more details, see Tolstoy, Hill & Tosi 2009, in press.

Within the Local Universe galaxies can be studied in great detail star by star, using a variety of techniques pioneered by members of this team. The Colour-Magnitude Diagram (CMD) synthesis analysis method is well established as the most accurate way to determine the detailed star formation history of galaxies back to the earliest times. This approach received a significant boost from the exceptional data sets the Hubble Space Telescope could provide. Spectroscopic studies using large ground based telescopes such as VLT, Magellan, Keck and HET have allowed the determination of abundances and kinematics for significant samples of stars in nearby dwarf galaxies. These studies have shown directly how properties can vary spatially and temporally, which gives important constraints to theories of galaxy formation and evolution, and have been recently summarized by Team applicants Tolstoy, Hill and Tosi in an invited

review paper to appear on the Annual Review of Astronomy and Astrophysics at the end of 2009. However there has not yet been a full combination of *all* these different data sets into self-consistent models. Nor a collaboration among scientists involved in observations or modelling in all the relevant sub-topics. This is the aim of our collaboration: take the most complete and accurate data sets (both from spectroscopy and from photometry acquired at the most powerful space and ground-based telescopes) on individual stars in Local Group dwarf galaxies, and incorporate them into state of the art models of chemical and dynamical evolution and thus obtain detailed understanding of dwarf galaxy evolution back to the epoch of formation.

The overlapping properties of early and late-type dwarfs which can be seen in Fig. 1 have long been considered as evidence that early-type dwarfs are late-type systems that have lost their gas (Kormendy 1985), through either tidal stripping or galactic winds triggered by supernova explosions. This is quite different from the distinction between Ellipticals and Spirals (and Spheroids), which show a fundamentally different distribution in Fig. 1. Dwarf galaxies cover a large range of size, surface brightness and distance, and so they are usually studied with different techniques with varying sensitivity. Some galaxies are just easier to study in detail than others (due to distance, size, concentration, location in the sky, heliocentric velocity etc...). Because of this, the properties and inter-relations of the various types of dwarf galaxy are not always easy to understand. We have undertaken a number of observational programmes (with HST and ESO/VLT) to obtain accurate imaging and spectroscopy data sets for a range of dwarf galaxy types, including ultra faint galaxies and large and small irregular systems. Additional data sets are being requested to further detail some of the features. Over the lifetime of this project we aim to interpret our consistent data sets for different types of systems to be able to make detailed and accurate comparisons of their properties and to understand how gas-rich galaxies can transform into gas-poor systems.

Our primary aim is to quantitatively explain the evolutionary link between early (gas-poor dwarf spheroidals and dwarf ellipticals) and late dwarf galaxies (gas rich dwarf irregulars and blue compact dwarfs). All these systems have numerous global properties in common (e.g., luminosity, surface brightness, size, metallicity, etc) and, most importantly, the relations between these global properties appear to follow a clear trend (see Fig. 1). This suggests that all these systems have had the same type of progenitors and some evolutionary effect determines how the star formation rate varies with time. This cannot be the mass alone, as galaxies with and without gas overlap at same mass values. Nonetheless, the smaller systems are much more susceptible to lose their gas both in the course of active star formation and supernova explosions and as the result of weak or strong tidal interactions with a larger system, such as our Milky Way.

As part of this goal we will also quantify the effect of galactic scale winds on the evolution of these small systems by comparing accurate abundance determinations and star formation histories within detailed chemo-dynamical evolution models. This will also allow us to determine how a starburst can occur and lead to a runaway star formation rate in some of these small systems.

The first chemical evolution models developed for dwarf galaxies were essentially constrained by the end points of galaxy evolution, namely the present-day (gaseous and stellar) masses and abundances for only a few elements (e.g., He, N, O, Ne, S and Ar) from observations of HII regions. Nevertheless, important conclusions were reached about the evolution of such low-mass systems, such as the need for a certain amount of primary nitrogen production in stars (see Lequeux et al. 1979, A&A, 80, 155). At present, for near enough objects, we can make use of high-resolution, high signal-to-noise spectroscopy of stars over a range of ages, which provides fundamental information about the evolution of several chemical species such as the alpha-elements (O, Mg, Si, Ca, Ti), the Fe-peak elements (Sc, V, Cr, Fe, Co, Ni), and the r- (Eu) and s-process elements (Y, Zr, Ba, La, Nd, Ce). A detailed analysis of how these different elements are synthesized by stars of different initial masses, and returned to the interstellar medium on different timescales and by

different mechanisms over the history of a galaxy has become possible with these new data sets. This allows us to accurately verify our understanding of stellar evolution and nucleosynthesis and also to constrain the timescale for galaxy formation and various evolutionary stages. The most recent chemical evolution models also benefit from a detailed knowledge of the star formation histories of the systems as well as their stellar initial mass function, which are both inferred from the analysis of deep CMDs. This allows stringent constraints on physical processes, such as the accretion of extragalactic matter from outside and the ejection of material previously processed in stars through galactic scale winds (see, e.g., Romano, Tosi & Matteucci 2006, MNRAS, 365, 759; Lanfranchi & Matteucci 2003, MNRAS, 345, 71). A fundamental goal of our ISSI project is to use new generation chemical evolution models to interpret the data available for Local Group dwarf galaxies, both early- and late-type, and study any possible connection in between the two classes.

Our chemical evolution code follows the evolution of more than 30 stable chemical species using a set of integro-differential equations describing the variation of the abundance of species by taking into account: i) any infall of gas onto the system; ii) gas astration according to the SFH specified by previous CMD analysis; iii) mass return from dying stars (taking into account in detail the stellar lifetimes, i.e., avoiding the instantaneous recycling approximation); iv) any loss of matter through galactic scale winds..

This effort will also prepare for future facilities both in space (e.g., JWST, GAIA) and on the ground (e.g., VLT/MUSE, WFMOS on Subaru).

EXPECTED OUTPUT

We expect to produce a number of high profile papers and conference talks from this effort. Depending on the outcome of the Team discussions, we might also envisage the possibility of applying for an ISSI Workshop to present and discuss with a wider community the results of the project, and its possible implications on Cosmology. If that was the case, both the Team results and the Workshop discussions and presentations would be published in a book of the ISSI series.

VALUE OF ISSI

The primary goal of our Team is to analyse the widely debated questions of whether late and early type dwarfs are evolutionary linked and whether they are likely to actually be the building blocks of big galaxies such as the Milky Way. Such hot issues require extended, open minded discussions. The team will result from the combination of scientists participating to different projects in different sub-topical areas, rarely interacting with each other: the friendly and informal atmosphere typical of ISSI meetings is exactly what is needed to allow for the open discussions between the various souls of the team, necessary for a successful and efficient collaboration. Moreover, Team members are affiliated to Institutes geographically far away from one another, so it is important to have an appropriate meeting venue to establish and maintain our collaboration especially in the initial stages.

THE TEAM

We have put together a team which combines several complementary skills to attack this problem in the most comprehensive way. The international team consists of experts in determining and interpreting high resolution spectroscopic abundances of individual stars in nearby galaxies, including the Milky Way (e.g., Hill, Shetrone, Venn), large-scale low-resolution spectroscopic surveys of nearby early and late-type

galaxies (e.g., Battaglia, Tolstoy, Irwin) and detailed Colour-Magnitude Diagram analysis of early and late-type galaxies (e.g., Tolstoy, Tosi, Cignoni) and HI studies of gas-rich galaxies (e.g., Sancisi). The team also includes modellers who will compare these new and highly detailed data sets with chemical evolution models (e.g., Romano, Tosi, Jablonka) as well as dynamical models (e.g., Helmi, Battaglia). We aim to make a targeted effort to understand and model recent diverse high quality data sets collected by various members of this proposed team. No other group or established team can carry out such an ambitious programme at present.

TEAM MEMBERS:

Eline Tolstoy (Groningen, NL)	Donatella Romano (Bologna, I)
Monica Tosi (Bologna, I)	Matthew Shetrone (Univ. Texas, USA)
Vanessa Hill (Nice, F)	Giuseppina Battaglia (ESO, D)
Amina Helmi (Groningen, NL)	Renzo Sancisi (Groningen+Bologna, NL+I)
Pascale Jablonka (Geneva, CH)	Kim Venn (Victoria, Ca)
Mike Irwin (Cambridge, UK)	Michele Cignoni (Bologna, I)

SCHEDULE OF THE PROJECT

We propose to hold an initial team meeting of one week to kick off the project during the autumn of 2009. Followed by a second meeting, also of one week duration about 9-10 months later, during late summer or early autumn of 2010. Ideally we would then hold a third and final meeting in spring of 2011. The con

FACILITIES REQUIRED

We only require meeting facilities, which should include a room large enough to comfortably accommodate us all, plus an additional 2 Phd students who might attend. We require projection facilities to which laptops can be attached. We would also require reasonably fast access to Internet (preferably via wireless).

FINANCIAL SUPPORT

We request the standard support provided by ISSI of a per diem for the living expenses of Team members while residing in Bern, plus travel costs for the Team Leader/Coordinator or a nominated alternative.

APPENDIX ITEMS

SHORT CVS FOR THE TEAM

Curriculum Vitae

Name: Eline Tolstoy
Address: Kapteyn Institute, Univ. of Groningen, Postbus 800, 9700AV, Groningen, NL
Tel: +31 50 3638323
Email: etolstoy@astro.rug.nl
Web: <http://www.astro.rug.nl/~etolstoy>

Career:

July 2006 – present
Associate Professor, Kapteyn Institute, Univ. of Groningen
July 2001 – June 2006:
KNAW (Royal Dutch Academy of Arts & Sciences) Fellow and
member of Faculty, Kapteyn Institute, Univ. of Groningen
June 2000- July 2001:
Gemini Support Scientist, Oxford University UK.
May 1998- May 2000:
ESO Postdoctoral Fellow, ESO, Garching, Germany
May 1996- May 1998:
ESA External Postdoctoral Fellow ST-ECF, Garching, Germany.
October 1995- May 1996:
Postdoctoral Research Assistantship, Space Telescope Science Institute
September 1990- October 1995:
Graduate Student Research Assistantship, Space Telescope Science Institute

PhD Students: Letarte (2007), Battaglia (2007), Starkenburg & de Boer (projected to finish in 2011)
Postdocs: Andrew Cole (2002-5), Emanuele Ripamonti (2004-7), Giuliana Fiorentino (2007-10)
Prizes: Pastoor-Schmeits Prize 2007, for research achievements of a young scientist in the Netherlands;
Teacher of the Year, Faculty of Mathematics & Natural Sciences, Groningen 2003, 2006
Funding: NWO/VICI 2007 (€ 1.5M); NWO Open Competition 2003 (€ 150 000); NWO Open
Competition 2002 (€ 200 000); KNAW Fellowship (2001-2006) (€ 350 000)

Selected Professional activities

- Key Researcher and national Co-I of the NOVA II and III grants (2001-present)
- NOVA - Dutch instrumentation steering committee (2001-2007)
- NWO - Dutch telescopes time allocation committee (2001-2003)
- ESO - Extremely Large Telescope Design Reference *Science Working Group* (2006-present).
- Directors advisory committee to the Isaac Newton Group Observatory, Dutch representative (2002-2008)
- HST – ESA member telescope time allocation panel member March 2007
- HST – ESA member telescope time allocation panel chair & member of TAC May 2008
- Gemini WFMOS Science team (2003-present)
- MICADO (ELT imager) Science team (Jan 2008 – present)
- HARMONI (ELT spectrograph) Science team (Mar 2008 – present)
- OPTIMOS (ELT spectrograph) Science team (Dec 2008 – present)
- ESO - telescope time allocation panels (2002-2004)
- Scientific Organising Committee, approx 10 international conferences

Publications:

Approx. 50 refereed publications (~2200 citations), 75 contributions to international meetings, including about 27 invited talks, and 3 graduate school lecture series.

Monica Tosi
INAF - Osservatorio Astronomico di Bologna

Career

- March 1980 - May 1981: Post Doctoral Fellow at the Yale Astronomy Department (New Haven, USA);
- April 1981 - 1989: Astronomer at the Bologna Astronomical Observatory;
- January - October 1986: Visiting Astronomer at the Space Telescope Science Institute (Baltimore, U.S.A.);
- September 1989 - 2001: Astronomo Associato (Associate professor) at the Bologna Observatory;
- October 2001 - present: Astronomo Ordinario (Full Professor) at the Bologna Observatory.

Selected Professional Activities

- November 1985 - present: member of the International Astronomical Union (IAU); member of the Organizing Committee of Commission 37 (Star Clusters and Associations) since 2005
- 1996: ESA member of the "Stellar Populations" panel for the HST TAC;
- 1998-2005: member of the group Local Late Galactic Evolution at the International Space Science Institute (ESA) in Bern (CH); co-chair since 2003;
- 1998-99: member of the "Nearby normal galaxies" panel in the ESO OPC;
- 2003-2006: ESA Member of the Space Telescope Users Committee (STUC)
- 2005: ESA Member of the HST TAC (chairperson of Panel Galac5);
- 2006: ESA Member of the HST TAC (chairperson of Panel ExGal1);
- 2006 - 2008: Member of the ESO OPC (chairperson of Panel D4);
- 2006 - present: member of the ESO ELT Standing Review Committee;
- 2006 - present: ESA member of the Institute Visiting Committee of the Space Telescope Science Institute (Baltimore, USA);
- 2008: chairperson of the ESO OPC
- 2008 - present: Member of the ISSI Science Committee
- 2009: chairperson of the ESO OPC Nominating Committee
- 2009-2012: ESA member of the JWST STAC (Science Technology Advisory Committee)

Research Activity

- Theoretical models for the chemical evolution of spiral and dwarf galaxies,
- Star formation histories of resolved galaxies,
- Open clusters as tracers of Galactic evolution.

Monica Tosi has published about 100 refereed papers, 20 invited reviews and 200 contributions to international meetings .

Curriculum Vitae of Amina Helmi

Contact: Kapteyn Astronomical Institute, University of Groningen, P.O. Box 800 - 9700 AV
Groningen – Netherlands, Tel: 31-50-3634045, Fax: 31-50-3636100.
E-mail: ahelmi@astro.rug.nl

Date and place of birth: October 6, 1970, Bahia Blanca, Argentina

Nationality: Argentine and Dutch

Academic Background

1997 - 2000 PhD from Leiden University on “*The Formation of the Galactic halo*”
(Cum Laude)

1989 - 1994 Astronomy degree, specialization in Theoretical Physics, from University of La Plata, Argentina (Grade average: 9.91 -out of maximum 10)

Employment

2007 – to-date Associate Professor, Kapteyn Astronomical Institute, Groningen, Netherlands

2003 - 2006 Assistant Professor, Kapteyn Astronomical Institute, Groningen, Netherlands

2002 - 2003 NOVA Postdoctoral Fellow, Astronomical Institute Utrecht, Netherlands

2001 - 2002 Postdoctoral Fellow, Max Planck Institut für Astrophysik, Garching, Germany

2000 Postdoctoral Fellow, University of La Plata, Argentina

Awards

2004 Christiaan Huygens Prize, Christiaan Huygens Foundation

2001 C.J. Kok prize, Leiden University

1995 and 1997 Amelia Earhart Fellowship Award, Zonta International Foundation

1994 Nomination for Best Student of the province of Buenos Aires, Argentina

1994 Mention for the highest grade-average of the University of La Plata, Argentina

1993 Award for Outstanding Students in Science, Fundacion Antorchas, Argentina

Membership of Learned Societies

The Young Academy of the Royal Netherlands Academy of Sciences, KNAW

International Astronomical Union

Supervisory Activities

Present: 4 PhD students (1 as co-advisor), 1 Bachelor student, and 1 Postdoc (Groningen)

Past: 3 PhD students; MSc and 2 Bachelor students.

Current Committee Memberships

- ESO/ESA Working Group on the Milky Way, 2007 -2008; Astronomy Working Group, ESA,

2007 – 2009; ASTRONET European Science Vision working group, panel B (Galaxies); RAVE

Executive Board; Grant Assessment Committee for Astronomy, NWO (since 2004)

Departmental Colloquia in the past 3 years

ESO/MPA/MPE Joint Astronomy Colloquium, 2008; ESTEC, Noordwijk, 2007; ASTRON,

Dwingeloo, 2007; Leiden, 2007; MPA, Heidelberg, 2006; University of Amsterdam, 2006

Miscellanea

-11 invited reviews in International conferences since 2006; 6 Departmental Colloquia since 2006

- Referee for grant allocation for UK; Argentina, Chile, Sweden, Germany

- Referee of Nature, ApJ, ApJL, AJ, MNRAS, A&A, PASA, PRD, PRL, Phys. Lett. A & B

- 53 peer-reviewed papers with 2431 citations, out of which 18 as first author

Matthew David Shetrone

CURRICULUM VITAE

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Education

Ph.D. Astronomy and Astrophysics, UC Santa Cruz, June 1996

Thesis Title: *Observational Tests of Deep Mixing in Population II Red Giants*

Advisor: Dr. Bob Kraft

M.S. Astronomy and Astrophysics, UC Santa Cruz, 1994

B.A. Astronomy and Astrophysics, University of Texas at Austin, 1991

High Honors; Special Honors in Astronomy

Experience

University of Texas, McDonald Observatory:

2007-present	Senior Research Scientist Head of Night Operations for HET
2004-2007	Research Scientist Head of Night Operations for HET Night staff hiring and training Night staff evaluations Leading Night Science Operations Operations
2002-2004	Research Scientist Lead Resident Astronomer for HET
2000-2002	RESA IV Lead Resident Astronomer for HET Coordinator of Engineering and Science Observing
Summer 2001	Lecturer for Observing Techniques
1998-2000	RESA III Resident Astronomer for Hobby-Eberly Telescope Telescope and Instrument Commissioning Queue Scheduled Service Observing

Sul Ross University, Alpine TX:

1999-2000 Guest Instructor for Intro. Physics

European Southern Observatory, Chile:

1996-1997 Research Fellow
Instrument Scientist for CASPEC and CES
Mountain and 3.6m Team Coordinator

Fellowships and Professional Societies

2007	McDonald Staff Excellence Award
2007-2009	PI for NSF Research Exp. for Undergraduates Grant: \$151,752
2003-2007	Co-PI for NSF Collaborative Research Grant: \$281,312
2003-2007	PI for NSF Research Exp. for Undergraduates Grant: \$137,322
2000	CoI for SIM Nstars grant (Grant canceled due to PI departure)
2000	International Astronomical Union Member
1996	European Southern Observatory Fellow
1995	Astronomical Society of the Pacific Member
1994	American Astronomical Society Member
1994-1995	Graduate Student Association President
1990-1991	Eva Stevenson Woods Endowed Presidential Scholar
1990	McDonald Observatory Undergraduate Summer Fellow
1989,1991	University of Texas College Scholar

Vanessa HILL
Born 2 September 1970
in Nice (France).
French citizen

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Observatoire de la Côte d'Azur, CASSIOPEE
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F-06304 Nice Cedex 4 (France)
Tel. 04 92 00 30 15
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Education:

1992: Degree in Physics, Nice Sophia Antipolis University
1993: Masters degree "Astrophysique et Techniques Spatiales", Paris 7 University
1997: PhD Thesis "Astrophysique et Techniques Spatiales", Paris 7 University:
"Evolution Chimique des Nuages de Magellan"

Work experience:

- 1993-1996: PhD studentship at Observatoire de Paris, working on the chemical analysis of young supergiants in the Magellanic clouds, under the supervision of Dr. Monique Spite. At the same time (1994-1996), I was also a teaching assistant at Paris13 University for 1st and 2nd year courses in computer science and maths.
- 1996-1997: ATER (associate teacher) at Paris13 University, teaching 2nd and 3rd year students in computer science and numerical recipes. My research during that year included analysis of the EROS experiment RR Lyrae stars in the Large Magellanic Cloud as probes of the old population in this galaxy.
- 1998 (6 months): Postdoctoral position at IAG, São Paulo (Bresil), working with Dr. Beatriz Barbay, on carbon-enhanced extremely metal-poor stars in the Milky Way
- 1998-2001: ESO Postdoctoral Fellow (Garching, Germany). Beside research, I participated to the testing and commissioning of the VLT UVES high-resolution spectrograph, as well its scientific operations.
- 2001- present: Chargée de Recherche (CNRS) at the Paris Observatory.

Instrumentation

During my ESO fellowship, I took an active part in the integration and commissioning of the UVES spectrograph at VLT. Back in France in 2001-2003, I followed the integration, testing and commissioning in the lab and at the VLT of the next spectrograph, the FLAMES multi-object instrument. I also coordinated the French Guaranteed Time Observations on FLAMES. I am now part of the ESO Extremely Large Telescope Science Working Group (2007-present), and the French representative at the ESO Users Committee (2008-present). I am also part of the steering committee for the Paris Observatory Instrumentation facility (Pole Instrumental) since 2002.

Other Academic activities:

In France:

- Scientific secretary of the Section 17 (Astrophysics) of the CNRS (committee in charge of new hires and evaluating CNRS research staff, nation-wide)
- Scientific council for the Programme National Galaxies (2004-2008), Programme National Physique Stellaire (2006-present) and Action Spécifique GAIA (2007-present), that award funding for moderate-size research projects across France on specific topics.
- Department council (2006-present)

International:

- Telescope time allocation comities for various telescopes: ESO (2006); TAC CFHT (2006-present); French national 2m class telescopes (2006-present).
- ESO Extremely Large Telescope Science Working Group (2007-present)
- French representative at the ESO Users Committee (2008-present)

DONATELLA ROMANO
Curriculum Vitae

Dipartimento di Astronomia, Università di Bologna
INAF-Osservatorio Astronomico di Bologna
Via Ranzani 1, I-40127 Bologna, Italy

Voice: +39 051 2095796
Fax: +39 051 2095700
E-mail: donatella.romano@oabo.inaf.it

Date of Birth: October 29, 1972

Citizenship: Italy

Research Interests: Galaxy formation and evolution; chemical evolution models of galaxies of different morphological type; stellar evolution and nucleosynthesis.

Education:

2002: PhD, Astrophysics, International School for Advanced Studies (SISSA/ISAS), Trieste, Italy
1998: Laurea Degree, Physics, Università degli Studi di Trieste, Trieste, Italy

Positions:

November 2008–Date: Postdoc, Dipartimento di Astronomia, Università di Bologna
January 2003–May 2008: Postdoc, INAF-Osservatorio Astronomico di Bologna
November 1998–October 2002: Graduate Student in Astrophysics, SISSA/ISAS
August 1998–November 1998: “Post-Laurea” Grant, Osservatorio Astronomico di Trieste

Donatella Romano has published 18 refereed papers and almost as many contributions to conference proceedings. Most of the published papers present new theoretical results about specific aspects of the chemical evolution of the Milky Way and/or small stellar systems (such as the dwarf galaxies NGC 1569 and NGC 1705 and the peculiar Galactic globular cluster Omega Centauri, thought to be the remnant of a dwarf satellite accreted by the Milky Way some 10 Gyr ago). The most recent, refereed publications relevant to the present proposal are listed below:

1. Romano D., Matteucci F., 2007, “*Contrasting copper evolution in ω Centauri and the Milky Way*”, MNRAS Letters, 378, L59
2. Romano D., Matteucci F., Tosi M., et al., 2007, “*The chemical evolution of Omega Centauri’s progenitor system*”, MNRAS, 376, 405
3. Romano D., Tosi M., Matteucci F., 2006, “*Formation and evolution of late-type dwarf galaxies. I. NGC 1705 and NGC 1569*”, MNRAS, 365, 759

Curriculum Vitae

Name: Mike Irwin
Department: Institute of Astronomy
Madingley Road
Cambridge, CB3 0HA
Telephone: 01223-764606
e-mail: mike@ast.cam.ac.uk

Current appointment: Director of Cambridge Astronomical Survey Unit,
Reader in Astrophysics
Date of appointment: 1st October 1998

Qualifications: 1970–1973 Degree, Physics University of York, 1st+distinction
1973–1976 PhD, Molecular Biology, University of Cambridge

Professional History

1976 – 1978 Postdoctoral Fellowship, University of York
1978 – 1980 Higher Scientific Officer, Joint Speech Research Unit, GCHQ
1980 – 1990 Senior Research Associate, Institute of Astronomy, Cambridge
1990 – 1996 Senior Scientific Officer, Royal Greenwich Observatory
1996 – 1998 Staff Astronomer, Royal Greenwich Observatory
1998 – 2008 Director of Cambridge Astronomical Survey Unit (CASU)
2008 – Reader in Astrophysics, Director CASU

Relevant Research Interests

- development of advanced statistical techniques to optimise the analysis and interpretation of complex data including detailed modelling and hypothesis testing
- applying astronomical statistical and image processing techniques to medical data analysis problems with the aim of producing robust automatic bulk processing systems
- information data mining from federated multi-source datasets to search for rare objects and to characterise ensemble population components
- devising automated pipeline processing techniques for optimal extraction of information from large astronomical datasets from telescopes such as WFCAM, VISTA, and VST
- carrying out and exploiting wide field sky astronomical surveys using next generation deep wide field sky surveys from optical and NIR mosaics, a particular interest is surveying external Local Group galaxies
- automating detailed spectroscopic analysis of both low and high resolution data for use in stellar atmosphere modelling and detailed abundance analysis
- developing and using time series analysis techniques to probe a variety of transient astronomical phenomena including: transiting planets, supernovae, stellar variability, binary systems, high proper motion objects, optical bursters

Name : JABLONKA Pascale
Birth date : 28 March 1965
Nationality : French
Affiliation : Université de Genève - EPFL
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51, Chemin des Maillettes, CH-1290 Sauverny
Tel : +41 22 379 24 69
Fax : +41 22 379 23 35
E-mail : pascala.jablonka@unige.ch

EDUCATION

- December 1991 : Doctorat d'Astrophysique et Techniques Spatiales de l'Université Paris VII.
- June 1988, DEA d'Astrophysique et Techniques Spatiales : Université Paris VII.
- June 1987, Maîtrise de Physique Fondamentale : Université Paris VI

CAREER PATH

- 2005- : On leave from the CNRS (Observatoire de Paris). Maître assistant, Université de Genève
- 1994 - : Research position at CNRS (Centre National de la Recherche Scientifique). Charge de Recherche Première Classe (CR1).
- 1992-1994 : Postdoctoral Fellowship at ESO (European Southern Observatory) - Garching bei München, Germany
- 1991-1992 : Teaching and Research Position at the University Paris XI. [Attachée Temporaire d'Enseignement et de Recherche (ATER) à l'Université Paris XI Orsay]

APPOINTMENTS

- Expert for the French National Research Agency • Expert for the Swiss National Science Foundation • Appointed member of the CSAA, Commission spécialisée Astronomie et Astrophysique de l'Institut National des Sciences de l'Univers • 2005-2006 : European Expert for the FPS Research Programme in Physics • 2003-2007 : French representative at the Users' Committee of the European Southern Observatory 2005-2007 : chair of the ESO Users' committee. • 2003-2005 : Member of the Observing Program Committee of the European Southern Observatory • 2003-2005 : Appointed Member of the CIO (Computing Advice Committee) of Paris Observatory • 2003-2005 : Appointed member of the CSE of the University Paris VII (Commission des Spécialistes, whose mission is to define the relevant subjects in astrophysics to be developed at the University and to recruit new researchers). • 2003 : Member of the Time Allocation Committee of Hubble Space Telescope • 2003 : Member of the CNRS Group of Prospective in Astronomy, entitled 'Thématiques scientifiques prioritaires', section Galaxies. • 1999-2003 : Elected Member of the Scientific Council of the Paris Observatory. In particular, active participation to the reorganization of the Observatory between January 2000 and February 2001 • 1994-1999 : Elected Member of the Scientific Council of Paris Observatory

SUBSET of PUBLICATIONS

• Sanchez-Blazquez, P., Jablonka, P., et al. : *Evolution of Cluster Red Sequences Galaxies from redshift 0.8 to 0.4 : ages, metallicities and morphologies*, accepted for publication in *A&A*, arXiv:0902.3392 • Fuentes-Carrera, I.; Jablonka, P., et al., *Evidence for metallicity spreads in three massive M 31 globular clusters*, 2009, *A&A*, 493, 769 • Dasai, V.; Dalcanton, J. J.; Aragon-Salamanca, A.; Jablonka, P. et al. *The Morphological Content of 19 FDSFS Clusters at $0.5 < z < 0.8$* , 2007, *ApJ*, 660, 1151 • Jablonka, P., Gargas, J., Goudreau, P. : *Stellar Population Gradients in Bulges along the Hubble Sequence : II. Their Relation with Galaxy Properties*, 2007, *A&A*, 474, 753

Family name: Battaglia
First name: Giuseppina
Institute: European Organisation for Astronomical Research in the Southern Hemisphere,
Karl-Schwarzschild-Strasse 2, D-85748 Garching bei München
Position: Postdoctoral Fellow

Education and research history:

- Nov 2007 – now: Postdoctoral Fellowship at ESO Garching
- June 2003- Sep 2007: Phd thesis at the Kapteyn Astronomical Institute, University of Groningen, NL. Title: "Chemistry and kinematics of stars in Local Group galaxies". Supervisors: Eline Tolstoy, Amina Helmi. Phd defense on 7 Sep 2007, *cum laude*
- Oct 1998 – Mar 2003: undergraduate studies in Astronomy at the University of Bologna, I. Master thesis: "Dark matter halo and warp of the galaxy NGC5055". Supervisors: Renzo Sancisi, Filippo Fraternali, Tom Oosterloo, Bruno Marano. Defense on 14 Mar 2003, 110/110 *cum laude*

Teaching experience and professional activities:

-Co-supervision of the undergraduate student P.Parisi for his master project
-Teaching assistant (2 years) at the Kapteyn Astronomical Institute for the undergraduate course on "Galaxies"
-Co-organization of weekly Journal Club meetings at ESO (since Nov 2008)
-Member of the selection committee of PhD students and Fellows at ESO Garching (1 year)
-Member of the Design Reference Mission for the European Extremely Large Telescope (E-ELT), with the aim of producing simulated data for the E-ELT science case "The Chemo-Dynamical Structure of galaxies"
-Collaboration with the scientific team of OPTIMOS-EVE, a Phase A study for an optical-near infrared multiobject spectrograph on the E-ELT.

First author publications in refereed astronomical journals:

-G.Battaglia, A.Helmi, H.Morrison, P.Harding, E.W.Olszewski, M.Mateo, K.C.Freeman, J.Norris, S.A.Shectman 2005, MNRAS, 364, 433 "The radial velocity dispersion profile of the Galactic halo: constraining the density profile of the dark halo of the Milky Way"

-G.Battaglia, F.Fraternali, T.Oosterloo, R.Sancisi 2006, A&A, 447, 49 "HI study of the warped spiral galaxy NGC 5055: a disk/dark matter halo offset?"

-G.Battaglia, E.Tolstoy, A.Helmi, M.J.Irwin, B.Letarte, P.Jablonka, V.Hill, K.A.Venn, et al. 2006, A&A, 459, 423 "The DART imaging and CaT survey of the Fornax dwarf spheroidal galaxy"

-G.Battaglia, M.J.Irwin, E.Tolstoy, V.Hill, A.Helmi, B.Letarte, P.Jablonka 2008, MNRAS, 383, 183 "Analysis and calibration of CaII triplet spectroscopy of red giant branch stars from VLT/FLAMES observations"

-G.Battaglia, A.Helmi, E.Tolstoy, M.Irwin, V.Hill, P.Jablonka 2008, ApJ, 681L, 13 "The Kinematic Status and Mass Content of the Sculptor Dwarf Spheroidal Galaxy"

GENERAL INFORMATION	<ul style="list-style-type: none"> • Michele Cignoni, born in Livorno, 29th of September, 1975 • <i>address</i>: Department of Astronomy, Bologna University. Via Ranzani 1. 40126 Bologna, Italy • <i>email</i>: michele.cignoni@unibo.it • <i>phone</i>: +393471361758 • <i>Current position</i>: post-doc (cofinanced by the INAF-Osservatorio Astronomico di Bologna) at the Astronomy Department, University of Bologna, Via Ranzani 1, 40127 Bologna
RESEARCH INTERESTS	<p>— Methods for obtaining the star formation histories of a mixed, resolved population through the use of color-magnitude diagrams; confrontation of observational data and models, and how much information can be obtained</p> <p>— All kinds of numerical simulations, general interest in stochastic models and statistical procedures</p> <p>— Structure and evolution of our Galaxy</p> <p>— Stellar evolution</p>
EDUCATION	<p>2001 Laurea (Degree) in Physics, University of Pisa, Advisor: V. Castellani</p> <p>2001 Ph.D. student, Physics Department, University of Pisa</p> <p>2005 post-doc fellowship (assegno di ricerca) at the INAF-Osservatorio Astronomico di Capodimonte, Salita Moirariello 16, 80131 Napoli, <i>duration</i>: 01/04/2005-31/10/2006, title: "Struttura ed evoluzione della Galassia: preparazione di una survey stellare con il VST"</p> <p>2006 Ph.D. doctor in Applied Physics, <i>Galileo Galilei Ph.D. School</i>, title of the thesis: "Star formation rate in the solar neighborhood", Physics Department, University of Pisa. Advisors: Scilla Degl'Innocenti, Steven N. Shore</p> <p>2006 post-doc fellowship (assegno di ricerca) by the Astronomy Department, University of Bologna, Via Ranzani 1, 40127 Bologna, <i>duration</i>: 01/11/2006-today, title "Studio della Storia di Formazione Stellare in Galassie Vicine", tutor: Monica Tosi</p>
REFEREED PAPERS:	<p>Castellani V., Cignoni M., Degl'Innocenti S., Petroni S., Prada Moroni P.G. <i>Galactic Models and White Dwarf Populations</i>; Monthly Not. Roy. Astron. Soc. (2002), 334, 69</p> <p>Valle G., Cignoni M., Shore S. N. <i>Theoretical color-magnitude diagrams and the star forming histories of interacting open multi-population model galaxies: bursts and busts</i>; Astron. Astrophys. (2005), 440, 473</p> <p>Cignoni M., Shore S. N. <i>Restoring color-magnitude diagrams with the Richardson-Lucy algorithm</i>; Astron. Astrophys. (2006), 454, 511</p> <p>Marconi M., Cignoni M., Di Criscienzo M., et al. <i>Predicted properties of RR Lyrae stars in the SDSS photometric systems</i>; Monthly Not. Roy. Astron. Soc. (2006), 371, 1503</p> <p>Cignoni M., Degl'Innocenti S., Prada Moroni P. G., Shore S. N. <i>Recovering the star formation rate in the solar neighborhood</i>; Astron. Astrophys. (2006), 459, 783</p> <p>Cignoni M., Ripepi V., Marconi M., Alcalá J. M., Capaccioli M., Pannella M., Silvotti R. <i>The Galactic Halo stellar density distribution from photometric survey data: results of a pilot study</i>, Astron. Astrophys. (2007), 463, 975</p> <p>Tosi M., Bragaglia A., Cignoni M., <i>The old open clusters Berkeley 32 and King 11</i>, Monthly Not. Roy. Astron. Soc. (2007), 378, 730</p> <p>Cignoni M., Tosi M., Bragaglia A., Kalirai J. S., Davis D. S., <i>Disentangling the Galaxy at low Galactic latitudes</i>, Monthly Not. Roy. Astron. Soc. (2008), 386, 2235</p> <p>Silvotti R., Catalan S., Cignoni M., Alcalá J. M., Capaccioli M., Grado A., Pannella M., <i>White dwarfs in the Capodimonte deep field</i>, Astron. Astrophys. (2009), DOI: 10.1051/0004-6361/20079137</p> <p>Cignoni M., Sabbi E., Nota A., Tosi M., Degl'Innocenti S., Prada Moroni P. G., Angeretti L., Carlson L. R., Gallagher J., Meixner M., Sirianni M., <i>Star formation history in the SMC: the case of NGC 602</i>, Astronomical Journal (2009), 137, 3668</p>

Name: Kim Venn

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CAREER:

Aug, 2005-present: Associate Professor, University of Victoria, BC, Canada
Aug, 2001- Aug, 2005: Associate Professor, Macalester College, Saint Paul, MN, USA
July 2002-June 2003: Visiting Astronomer, Institute of Astronomy, Univ. Cambridge, UK
Aug, 1996- Aug, 2001: Assistant Professor, Macalester College, Saint Paul, MN, USA
Aug, 1994- Aug 1996: Postdoc, Max Planck Institute for Astrophysics, Munich, Germany
1994: Ph.D, University of Texas at Austin

Graduate Students: Vermedhal (MSc 2004), Chutter (MSc 2008), Leaman (MSc 2008; PhD present)

Postdocs: Bart Pritzl (2003-2005)

Prizes: Presidential Early Career Award in Science and Engineering (PECASE) 2000 for top young scientists in the US (nominated by NSF); Canada Research Chair Tier II (2005-present), national award for top Canadian scientists in the early stages of their career.

SELECTED PROFESSIONAL ACTIVITIES:

- European Southern Observatory (ESO), Observing Programs Committee (OPC): vice-chair of the OPC (Nov 2008 – present), chair of D1 subpanel on stellar evolution (May 2008 – present)
- National Optical Astronomical Observatories (NOAO): Galactic TAC panel chair (2007-2008), regular panel member (2001-2004)
- Canada-France-Hawaii Telescope (CFHT); Large Programs review panel member (May 2008), referee for regular proposals (2000-present)
- National Science Foundation (NSF) panel member; Stars panel (2009), CAREER program (2000), Astronomy Postdoc Fellowships (2007), ILI program (1999)
- Space Telescope Science Institute (STScI) Hubble Space Telescope Review Panel; Cool Stars and Stellar Populations (2007, 2004), Hot Stars (1998).
Cool Stars (2004), Cool Stars and Stellar Populations (2007)
- LACIR team member, an adaptive optics lab at UVic with TMT contracts.
- Gemini WFOS science team member (2006 – present)
- TMT IRMOS and TMT HROS science team member
- SOC for 7 international conferences.

PUBLICATIONS

Approx. 50 refereed publications (over 2000 citations), 12 invited talks at international meetings and ~50 other conference contributions.

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