1. Meeting Number: **Symposium 329**

2. Meeting Title: **The lives and death-throes of massive stars**

3. Coordinating Division: **Division G Stars and Stellar Physics**

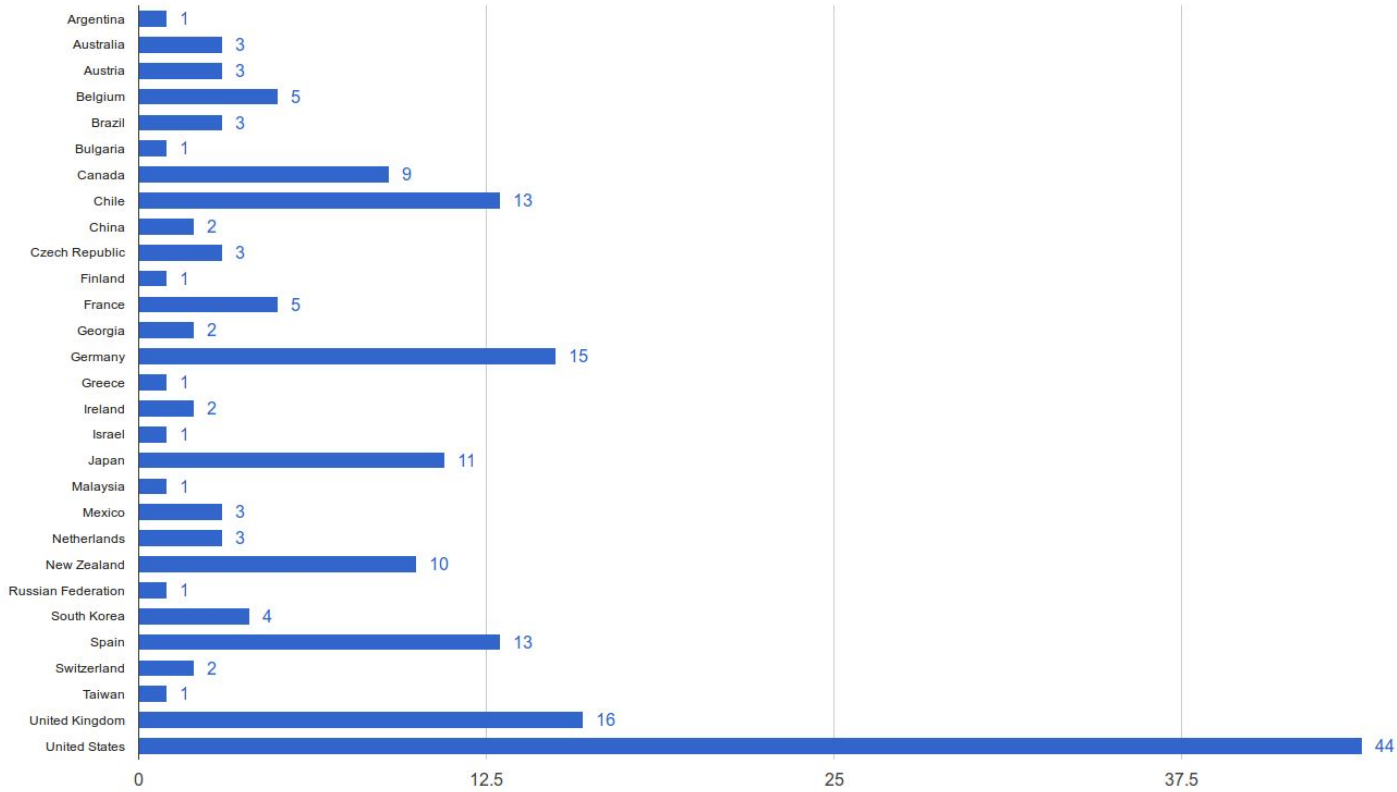
4. Dedication of meeting (if any): none

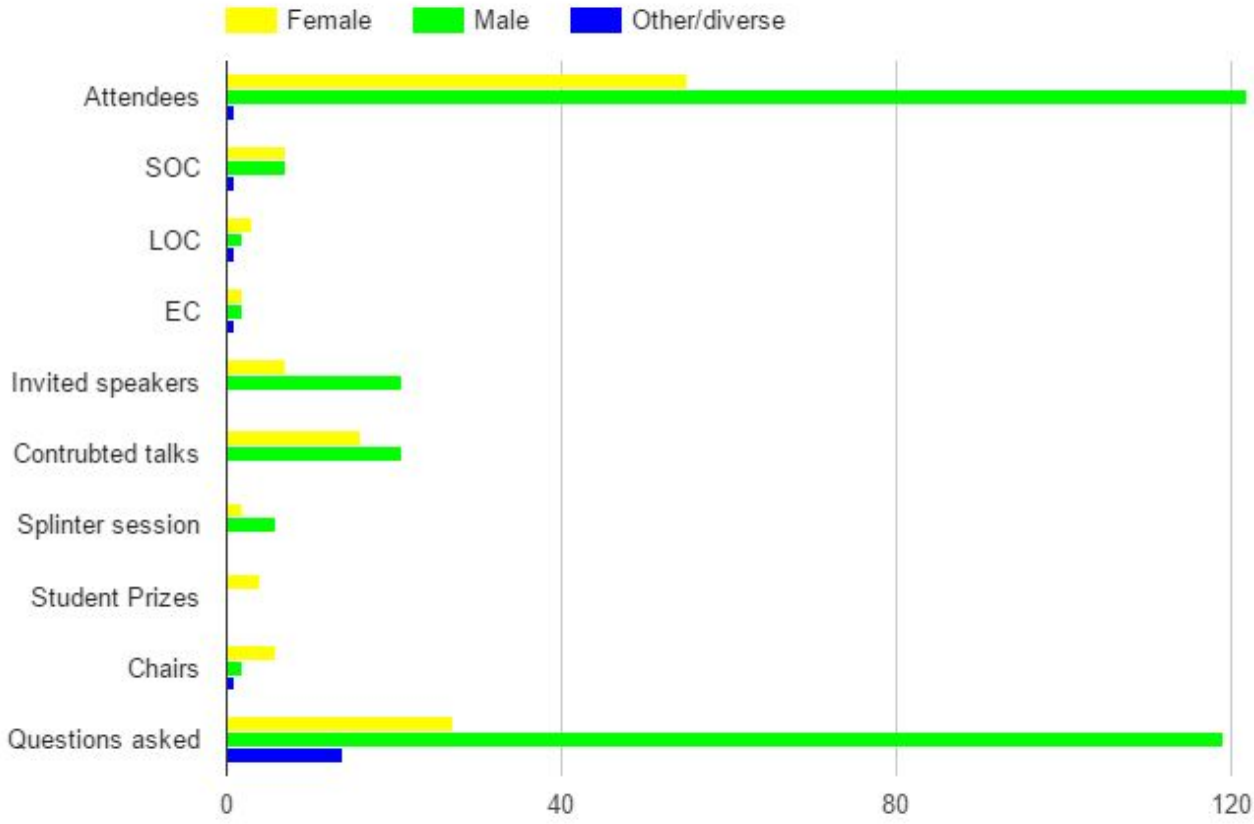
5. Location (city, country): **Auckland, New Zealand**

6. Dates of meeting: **28th November to 2nd December 2016**

7. Number of participants: 178, (M, F, D = 122, 55, 1 = 68.5%, 30.9%, 0.6%) Further equity information is included in the executive summary.

8. List of represented countries:

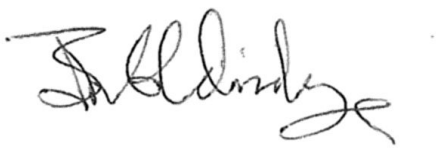




9. Report submitted by: Dr J.J. Eldridge

10. Date and place: Auckland, January 2017.

11. Signature of SOC co-chair and LOC chair



Dr JJ Eldridge

Executive summary

The meeting covered 4 broad areas related to massive stars and included one splinter session. The topic were:

1) Massive stars deaths in core-collapse supernova and other events.
2) Observations of massive stars.
3) Theoretical modelling of massive stars.
4) Massive stars as building blocks of galaxies through the history of the Universe.
5) Splinter session: X-ray observations of massive stars

During the week the linkage between these sessions with strong with several talks being able to be placed in any of the sessions. This reflects the growing collaborative nature of the study of massive stars. Formal discussion during the week was kept to a minimum. However long breaks were worked into the schedule to encourage informal discussion during the week. This was also further encouraged by setting the room up in a cabaret style with round tables rather than the normal lecture room format. Thus allowing people to form round table discussion groups. There was an extended discussion on Thursday run by Nathan Smith and Jose Groh concerning the best observations to test our theoretical models. In some ways bringing together all the topics of the week so far.

We are also particularly proud that our meeting from the onset worked hard to achieve an equitable meeting. Key to this was setting up an balanced SOC with 7 men, 7 women and 1 person of diverse gender. Also in selecting invited and contributed abstracts members were reminded to think about achieving an equitable balance at the meeting and to give people who don't always get a chance to speak an opportunity. Our efforts appears to pay off.

While overall 68% of the talks were by men and 32% by women. This was representative of the number of abstracts submitted and similar to the balance of attendees (Men 68.5%, Women 30.9%, Diverse 0.6%). While on the first day we were able to achieve equity with the ratio at 48% to 52%. With also good geographic diversity in speakers throughout the week in addition to this.

The meeting also had a code of conduct to make the meeting spaces safe, inclusive and free of harassment. A reporting proceeding was explained on the first day as well as identifying those on the "equity committee" who were responsible for enforcing the code. The experiment worked well but in future we recommend that the process to deal with breaches of the code of conducts be outlined before the meeting rather than being dealt with if incidents occur.

We also recorded further equity information such as the gender of those who asked questions. We are still analysing this data but of the 160 questions asked 74% were asked by men, 17% were asked by women and 9% by asked by people of diverse gender. We should note that in all the above statistics we are using the presumed gender. We only know of one gender diverse person who attended and asked those questions.

Our treatment of equity at the meeting also went beyond the talks and discussion. During the conference dinner for example we worked hard to provide entertainment that did not appropriate local culture and continue the safe inclusive environment. The result of this was to use a conference quiz (based on the "pub quiz" format common in the UK, Australia and New Zealand). It was enjoyable and some remarked it was the most enjoyable conference dinner they had attended.

In addition to IAU sponsorship for travel grants it was also sponsored by the Department of Physics from the University of Auckland as well as CAASTRO (ARC Centre of Excellence for all-sky astrophysics). Then on the day after the meeting several conference attendees contributed to a public symposium. Where the highlights of the meeting were discussed along with varied subjects from ancient astronomy, the structure of the Galaxy and science-fiction comic books.

There were two conference excursions, one to the Domain museum in Auckland the other a trip to Rangitoto island. A volcano in the bay of Auckland that erupted some 600 to 800 years ago. Surprisingly (to the tour organizer) 150 of the attendees went on the latter trip. Many enjoyed the race to the summit, exploring the lava caves afterwards and investigating a Kiwi bach (holiday home). The tour operator who organized the trips also made themselves available during the week to answer questions from attendees to plan their future travel in New Zealand after the conference.

At the end of the meeting and afterwards we received great positive feedback on our organization of the meeting. With the worst points being around trouble with the AV systems. Students and early-career researcher seems to be those who enjoyed the meeting the most and we hope that man productive collaborations will arise due to the meeting.

Science Organizing Committee
Co-Chairs: JJ Eldridge, Margaret Hanson, Artemio Herrero
Joe Anderson, Matteo Cantiello, Ben Davies, Sylvia Ekström, John Hillier, Coralie Neiner, Maria-Fernanda Nieva, Lida Oskinova, Alicia Soderberg, Nicole St-Louis, Jorick Vink, Sung-Chul Yoon

Local Organizing Committee
JJ Eldridge, Aimee Crawshaw, Lin Xiao, Liam McClelland, John Bray, Nicole Rodrigues

Equity Committee
JJ Eldridge, Margaret Hanson, Phillip Massey, Jennifer Hoffman, Liam McClelland, Lin Xiao

Gender Breakdown Information

Group	Number of Male:Female:Diverse	% of Male:Female:Diverse
SOC	**7 : 7 : 1**	**47% : 47% : 6%**
LOC	**2 : 3 : 1**	**33% : 50% : 17%**
EC	**2 : 2 : 1**	**40% : 40% : 20%**
Invited Speakers	**21 : 7 : 0**	**75% : 25% : 0%**
Contributed Speakers	**27 : 16 : 0**	**63% : 37% : 0%**
Splinter Session Speakers	**6 : 2 : 0**	**75% : 25% : 0%**
Student Prizes	**0 : 4 : 0**	**0% : 100% : 0%**
Chairs	**2 : 6 : 1**	**22% : 67% : 11%**
Questions asked	**119 : 27 : 14**	**74% : 17% : 9%**

Science highlights

The scientific program for the meeting was structured around 4 broad themes concerning massive stars: their supernovae, observations, theory and as constituents of galaxies. We summarize the important topics from each of these themes below.

1) **Massive stars deaths in core-collapse supernova and other events.**

Core-collapse supernovae are the final death throes of massive stars. At the meeting much was presented on recent observational surveys which are redefining our understanding of the rates of different supernova types. Especially finding more examples of the rarer types including superluminous supernova. In addition to larger samples of supernova much has been done in adding more varied observational constraints on the supernova and their progenitor stars. Especially understanding the mass-loss history of progenitors before explosion. Then there are also novel observational tests such as studying nearby stellar populations close to SN sites both by studying the stars as well as the nebula emission that arises from the population associated with the star that died. We also heard how polarization informs our knowledge of the supernova explosion mechanisms and heard our first mention that polarimeters need to be added to future plans for telescope instrumentation.

These advancements have been accompanied by great advances in understanding of the mechanisms around core-collapse and how stars explode. With there also being other ways to explode stars via jets as well as the typical core-collapse alone We also heard how that stars in interacting binaries are vital to understanding the variety and progenitors of many core-collapse supernovae.

2) **Observations of massive stars.**

The same broad lessons were repeated in this session. That of how new techniques and new spectroscopic large surveys are providing a wealth of information to refine our understanding of massive stars. Magnetic fields have been detected in many stars now, although future detections rely on more polarimeters on large telescopes being made available in future. Also while the new technique of asteroseismology is beginning to provide a window into the interior of massive stars however direct studies of massive stars are few to date. Observations of main-sequence stars in addition to revealing their intrinsic parameters are also giving us a better understanding of the number of binary stars is extremely high. And somewhat more astonishing the number of triple and higher order systems is not insignificant.

Great advances have also been made in our knowledge of red supergiants and Wolf-Rayet stars due to careful theoretical work and observational work in unison. Finally the importance of the detection of gravitational wave sources indicating massive black holes can exist in binary systems featured in many talks. Especially those concerning massive X-ray binaries which are likely to be the progenitors of such systems.

3) **Theoretical modelling of massive stars.**

The greatest advances in theory concerned first the improved understanding of binary evolution and interactions, specifically our knowledge of common-envelope evolution. Then second advances concerned the modelling of stellar atmospheres and stellar structure below the photosphere. This has led have allowed tighter constraint on Wolf-Rayet stars and their complex surfaces. The impact of magnetic fields in the surface of stars have also now been refined to a great degree.

4) **Massive stars as building blocks of galaxies through the history of the Universe.**

On the final day the conference turned to massive stars as constituents of Galaxies from our own to those at the edge of the observable Universe. Again large surveys are providing again most data to constrain our understanding and using massive stars to understand larger objects. Most interesting the case was made that in future members of the high-redshift community will being to realise more and more that to unlock further knowledge of the first galaxies it will be necessary to understand all the current uncertainties covered earlier in the week.

5) **Splinter session on X-ray observations of massive stars**

The final science session was a splinter session on the X-ray observations of massive stars. This linked strongly into other sessions of the program. Many of the talks related back to the study of magnetic fields and binary systems and thus was most complementary to the meeting.

Final Program

MONDAY			**Chair: JJ Eldridge**
9.15-9.30			**Introduction and Mihi Whakatoa**
9.30-10.10	Meynet	Georges	Overview of recent developments in stellar theory and supernovae
10.10-10.30	Bianco	Fed	Invited: Difference between Iib/Ib/Ic/Ic-BL
10.30-11	**Morning Coffee**		
11.00-11.20	Muller	Bernhard	Invited: Core-collapse SNe modelling - how many ways can you explode a star?
11.20-11.40	Hillier	Desmond John	Invited: Quantitative spectroscopy of supernovae
11.40-11.55	Nomoto	Kenichi	Radiation Hydrodynamics of Type I Superluminous Supernovae: Constraints on Progenitors and Explosion Mechanisms
11.55-12.10	Thöne	Christina	SN 2015bh: an LBV becomes NGC 2770s forth SN... or not?
12.10-12.25	Xiao	Lin	Emission-line diagnostics of Nearby HII Regions including Supernova host
12.25-12.40	Drout	Maria	Probing the Extremes of Pre-SN Mass Loss with the PanSTARRS1 Medium-Deep Survey
12.40-14.00	**Catered Lunch**		
			Chair: Margaret Hanson
14.00-14.20	Bersten	Melina	Invited: Modelling the SN and progenitors
14.20-14.40	Fraser	Morgan	Invited: Progenitors of core-collapse supernovae
14.40-15.00	Groh	Jose	Invited: Spectroscopic evolution of supernova progenitors
15.00-15.15	Smith	Nathan	Challenges to stellar evolution from LBVs, SN Impostors, and Supernovae with Dense CSM
15.15-15.30	Podsiadlowski	Philipp	Binary Evolution and the Final Fate of Massive Stars
15.30-16.10	**Afternoon Coffee**		
16.10-16.25	Hoffman	Jennifer	Reconstructing the Scene: New Views of Supernovae and Progenitors from the SNSPOL Project
16.25-16.40	Beasor	Emma	The evolution of red supergiants to supernovae
16.40-16.55	Menon	Athira	The quest for blue supergiants: Binary merger models for the evolution of the progenitor of SN 1987A
16.55-17.10	Yusof	Norhasliza	Very Massive Stars at Different Metallicities
17.10-17.25	Agliozzo	Claudia	The mass-loss before the end: two luminous blue variables with a collimated stellar wind
17.25-17.40	Ertl	Thomas	The progenitor-remnant connection of neutrino-driven supernovae across the stellar mass range
TUESDAY			**Chair: Sung-Chul Yoon**
9.00-9.20	Simon-Diaz	Sergio	Invited: Multi Epoch views of massive stars
9.20-9.40	Fuller	Jim	Invited: Asteroseismology of massive stars
9.40-10.00	Wade	Gregg	Invited: Magnetic fields in massive stars
10.00-10.15	Shultz	Matthew	Rotation, Evolution, Magnetic Fields, and Emission: Results from the First Population Study of Magnetic Early B-type Stars

10.15-10.30	**Rubio**	**Maria del Mar**	Re-examining the upper mass limit of stars using an isolated ~140 Msun twin of R136's WNh5 core stars
10.30-11.10	**Morning Coffee**		
11.10-11.25	Maíz Apellániz	Jesús	Gaia and spectroscopic surveys of O stars: the solar neighborhood in 6-D
11.25-11.40	Oksala	Mary	The evolution of magnetic fields in hot stars
11.40-11.55	**Buysschaert**	**Bram**	Magneto-asteroseismology of hot stars
11.55-12.10	Oskinova	Lidia	X-ray diagnostics of massive star winds
12.10-12.25	Gies	Douglas	Taking the Measure of Massive Stars and their Environments with the CHARA Array Long-baseline Interferometer
12.25-14.30	**Long Lunch Break to explore**		
			Chair: Melina Bernsten
14.30-14.50	Nieva	Maria-Fernanda	Invited: High accuracy quantitative spectroscopy in the Galaxy
14.50-15.10	Barba	Rodlofo	Invited: OWN, a survey of O and WR stars
15.10-15.30	Ohnaka	Keiichi	Invited: Resolving the mass loss from red supergiants by high angular resolution
15.30-15.45	Massey	Philip	The Red Supergiant Content of the Local Group
15.45-16.00	Scicluna	Peter	A high-contrast imaging survey of nearby red supergiants
16.00-16.40	**Afternoon Coffee**		
16.40-16.55	Hainich	Rainer	The metallicity dependence of WR winds
16.55-17.10	**Neugent**	**Kathryn**	The Evolutionary Status of WN3/O3 Wolf-Rayet Stars
	SPLINTER SESSION		**Chair: Lida Oskinova**
18.00-18.12	Kretschmar	Peter	Studying Stellar Winds in Massive X-ray Binaries
18.12-18.24	Nazé	Yaël	X-rays from colliding winds in massive binaries
18.24-18.36	Hamaguchi	Kenji	Origin of Extremely Hard X-ray Emission from Eta
18.36-18.48	Schulz	Norbert	X-ray Emission from Massive Stars at the Core of
18.48-19.00	Russell	Chris	Modeling the Chandra observations of the Galactic Center
19.00-19.12	**Fletcher**	**Corinne**	Investigating the Magnetospheres of Rapidly
19.12-19.24	Maravelias	Grigoris	The circumstellar environment of B[e] Supergiants
19.24-19.36	**Dorn-Wallenstein**	**Trevor**	A Candidate Red Supergiant X-ray Binary in M31
WEDNESDAY			**Chair: Yael Naze**
9.00-9.20	Caballero-Nieves	Saida	Invited: The Young and the Massive: Stars at the upper end of the Initial Mass Function
9.20-9.40	Sana	Hugues	Invited: Multiplicity of massive stars
9.40-10.00	Postnov	Konstantin	Invited: Progenitors of the black-hole binary mergers detected by LIGO
10.00-10.15	Pablo	Herbert	The Most Massive Heartbeat : Finding the Pulse of Iota Orionis
10.15-10.30	Damineli	Augusto	Eta Carinae A: a star with a hole

10.30-11.30	**Morning Coffee - EXTENDED POSTER SESSION SPONSERED BY CAASTRO**		
THURSDAY			**Chair: Bernhard Muller**
9.00-9.20	Georgy	Cyril	Invited: Evolution models of red supergiants
9.20-9.40	Justham	Stephen	Invited: Massive binary stars
9.40-10.00	Ivanova	Natalia	Invited: Common envelope: progress and transients
10.00-10.15	Hamann	Wolf-Rainer	Massive stars in advanced evolutionary stages, and the potential progenitors of GW150914
10.15-10.30	Sabín-Sanjulián	Carolina	Properties of the O dwarf population in 30 Doradus
10.30-11.10	**Morning Coffee**		
11.10-11.25	Augustson	Kyle	The Magnetic Furnace: Intense Core Dynamos in B Stars
11.25-11.40	**Cristini**	**Andrea**	3D Hydrodynamic Simulations of the Carbon Shell in a Massive Star
11.40-12.00	Gräfener	Götz	Invited: Clumping in stellar winds and interiors
12.00-12.20	Sander	Andreas	Invited: Recent advances in NLTE stellar atmosphere models
12.20-12.35	Jiang	Yanfei	3D Radiation Magnetohydrodynamic Simulations of Massive Star Envelopes at the Iron Opacity Peak
12.35-12.50	Bard	Christopher	Effect of a Dipole Magnetic Field on Massive Star Line-Driven Winds
12.50-14.30	**Long Lunch Break to explore**		
14.00-14.30	**LSST Transients and Variable Stars Discussion**		
			Chair: Jennifer Andrews
14.30-14.45	**Erba**	**Christiana**	New Insights into the Puzzling P-Cygni Profiles of Massive Magnetic Stars
14.45-15.00	Murphy	Jeremiah	The Spatial Distribution of Massive Stars and Stellar Evolution
15.00-15.15	**Goetberg**	**Ylva**	The Elusive Population of Massive Binary Star Products: the far UV Spectra of Stripped Stars
15.15-15.30	**Keszthelyi**	**Zsolt**	The evolution of magnetic hot massive stars: implementation of the quantitative influence of surface magnetic fields in modern models of stellar evolution
15.30-15.45	Cantiello	Matteo	The Stellar Ultrasound
15.45-16.00	**McClelland**	**Liam**	Helium stars: Towards an understanding of Wolf-Rayet evolution
16.00-16.30	**Afternoon Tea**		
16.30-17.00			**Discussion led by Nathan Smith & Jose Groh**
FRIDAY			**Chair: Jennifer Hoffman**
9.30-9.50	Chené	André-Nicolas	Invited: Massive infrared clusters in the Milky Way
9.50-10.10	Negureruela	Ignacio	Invited: Massive stars in Galactic clusters

10.10-10.30	Vink	Jorick	Invited: The VLT-FLAMES Tarantula Survey
10.30-11.10	**Anti-hangover coffee**		
11.10-11.25	Najarro	Francisco	The Massive stellar population at the Galactic Center
11.25-11.40	Crowther	Paul	The Tarantula as a template for extragalactic star forming regions from VLT/MUSE
11.40-12.00	Urbaneja	Miguel	Invited: Extragalactic supergiants
12.00-12.20	Stanway	Elizabeth	Invited: What Distant Galaxies can tell us about Massive Stars"
12.20-12.40	Herrero	Artemio	& Miriam Garcia Garcia, Invited: Winds of low metallicity OB stars
12.40-14.00	**Catered lunch**		
			Chair: JJ Eldridge
14.00-14.15	Leitherer	Claus	The II Zw 40 Supernebula: 30 Doradus on Steroids
14.15-14.30	Smith	Linda	The Very Massive Star Content of the Nuclear Star Clusters in NGC 5253
14.30-14.45	Davies	Benjamin	Red Supergiants as Cosmic Abundance Probes
14.45-15.00	Mattila	Seppo	High angular resolution infrared and radio view of optically dark supernovae in luminous infrared galaxies
15.00-15.30	**Afternoon Tea**		
15.30-16.00	Levesque	Emily	Conference Summary & Overview

List of Attendees:

First Name	Last Name	Department	Organization	Primary Address - Country	Primary Email
Michael	Abdul-Masih	Institute Of Astrophysics	Ku Leuven	Belgium	mabdul02@villanova.edu
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Beasor	Emma	Female	United Kingdom	400
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Cure Ojeda	Michel	Male	Chile	350
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Gómez-González	Víctor Mauricio Alfonso	Male	Mexico	400
Gordon	Michael	Male	USA	400
Gunawan	Diah Y A S	Female	Chile	400
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Haubois	Xavier	Male	CHILE	400
Hervé	Anthony	Male	czech republic	400
Higgins	Erin	Female	NI, UK	200
Hoffman	Jennifer	Female	USA	350
Holgado Alijo	Gonzalo	Male	Spain	400
Huk	Leah	Female	United States	400
Hypolite	Delphine	Female	France	400
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Kochiashvili	Nino	Female	Georgia	800
Kool	Erik	Male	Australia	400
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Maravelias	Grigoris	Male	Czech Republic	400

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Narita	Makoto	Male	Japan	400
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