# HAVE OBSERVATIONS REVEALED A VARIABLE UPPER END OF THE INITIAL MASS FUNCTION?

SEDONA ARIZONA • JUNE 20TH - 25TH • 2010

## Program/Schedule

### Sunday, June, 20th

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| **6:00 - 8:00 PM** | **Registration and Reception (Village Terrace)** |

### Monday, June, 21st

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| **7:30 - 9:00 AM** | **Breakfast** |
| **9:00 - 10:50 AM** | **Session I (moderator: Krumholz)** |
| Lee | Welcome |
| Zinnecker | Perspectives on Variations in the Upper End of the IMF |
| Clarke | The maximum stellar mass in clusters: evidence from observations and hydrodynamical simulations |
| Weidner | The galaxy-wide IMF - from star clusters to galaxies |
| **10:50 - 11:10 AM** | **Coffee Break** |
| **11:10 - 12:40 PM** | **Session I Continued (moderator: Oey)** |
| Massey | What the Stellar Content of OB Associations Tell Us (and Not) About the Slope of the IMF and Upper Mass Cutoffs |
| Selman | Around the Tarantula and into the Arches: a Salpeter IMF in the field and in clusters. |
| Comeron | RCW 108: Massive star formation in a nearby troubled environment |
| **12:40 - 2:30 PM** | **Lunch** |
| **2:30 - 4:00 PM** | **Session II (moderator: Oey)** |
| Stolte | Clusters near the center of the Galaxy - how weird is their IMF? |
| Johnston | Probing the origin of the IMF in regions of massive star formation |
| Lu | Mass Functions for Young Starburst Clusters in Different Milky Way Environments |
| **4:00 - 4:30 PM** | **Coffee Break** |
| **4:30 - 5:30 PM** | **Session II Continued (moderator: Krumholz)** |
| Oey | OB Stars in Stochastic Regimes |
| Vink | How massive is the most massive star? |

## Tuesday, June, 22nd

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| **7:30 - 9:00 AM** | **Breakfast** |
| **9:00 - 10:40 AM** | **Session III (moderator: Ferguson)** |
| Krumholz | How Does Radiation Feedback Affect Fragmentation and the IMF? |
| Smith | Can environmental conditions affect the upper end of the IMF? |
| Scoville | Determining the Upper End Requires Knowing the Lower End |
| Hsu, Urban | Poster summaries |
| **10:40 - 11:00 AM** | **Coffee Break** |
| **11:00 - 12:40 PM** | **Session III Continued (moderator: Ferguson)** |
| Corbelli | The Cluster Birthline and the formation of stellar clusters in M33 |
| Calzetti | A New Approach to Measuring the Stellar IMF |
| Cerviño | From CMDs to Integrated properties: Probabilistic synthesis models |
| Wofford, Kim, Fumagalli | Poster summaries |
| **12:40 - 12:50 PM** | **Conference Group Photo** |
| **12:50 - 2:30 PM** | **Lunch** |
| **2:30 – 4:00 PM** | **Session IV (moderator: Ferguson)** |
| Zinnecker | The Chances of Massive Star Collisions in the Center of the R136 Cluster Core |
| Whitmore | Luminous Stars in Galaxies Beyond 3 Mpc |
| Weisz | Constraints on the Field Star IMF from Resolved Stellar Populations based Star Formation Histories |
| **5:45 – 8:00 PM** | **Sunset Jeep Tour (meet at Village Terrace)** |

## Wednesday, June, 23rd

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| **7:30 – 9:00 AM** | **Breakfast** |
| **9:00 - 10:30 AM** | **Session V (moderator: Schiminovich)** |
| Lee | UV/H-alpha Turmoil |
| Meurer | Upper-End IMF Variations Deduced From HI Selected Galaxies |
| Boselli | High Mass Star Formation in Normal Late-Type Galaxies: Observational Constraints to the IMF |
| **10:30 - 11:00 AM** | **Coffee Break** |
| **11:00 - 12:40 PM** | **Session V Continued (moderator: Schiminovich)** |
| Thilker | The role of extended ultraviolet disk (XUV-disk) galaxies in the IMF controversy |

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| Eldridge | How star-formation rate indicators vary with the IMF and how it is sampled. |
| Johnson | Fitting the UV through IR SED of Galaxies in the Local Volume |
| Wyder, Donovan-Meyer, Zhang | Poster summaries |

**12:40 - 2:30 PM** **Lunch**
**2:30 - 4:00 PM** **Session VI (moderator: Gallagher)**

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| Hoversten | Evidence for IMF Variations from the Integrated Light of SDSS Galaxies |
| Dabringhausen | Top-heavy IMFs in ultra-compact dwarf galaxies? |
| Pflamm-Altenburg | Applications of the IGIMF-theory |

**4:00 - 4:30 PM** **Coffee Break**
**4:30 - 6:00 PM** **Session VI Continued (moderator: Gallagher)**

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| Jungwiert | N-body simulations of disk galaxies with long-term stellar mass-loss within the IGIMF framework |
| Calura | The Role of the IGIMF in the chemical evolution of the solar neighbourhood |
| Zahid | Poster summary |
| Kroupa | Some implications of the variable galaxy-wide IMF |

## Thursday, June, 24th

**7:30 - 9:00 AM** **Breakfast**
**9:00 - 10:30 AM** **Session VII (moderator: Gallagher)**

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| Madore | What Is This Thing Called the Schmidt Law? |
| Gunawardhana | The dependence of the stellar initial mass function on the galaxy star formation rate |
| Leitherer | Constraints on the Upper IMF from Ultraviolet Spectral Lines |

**10:30 - 11:00 AM** **Coffee Break**
**11:00 - 12:30 AM** **Session VII Continued (moderator: Scoville)**

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| Neill | Measuring the Upper End of the IMF with Supernovae |
| Cooke | Type IIn supernova detections in z ~ 2 Lyman break galaxies: Probing the IMF directly |
| Le Tiran | The turbulent ISM of galaxies about 10 Gyrs ago: an impact on their IMF? |

**12:30 - 2:30 PM** **Lunch**
**2:30 - 4:05 PM** **Session VIII (moderator: Scoville)**

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| Hayward | The IMF in z~2 Starbursts: Evidence for Minimal Variations from Local Mass Functions |

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| Wilkins | The Effect of an Evolving IMF on the Cosmic Star Formation History |
| Reddy | Reconciling the Star Formation and Stellar Mass Density Histories |
| Watson, Giavalisco, Pflamm-Altenberg | Poster summaries |

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| **4:05 - 4:30 PM** | **Coffee Break** |
| **4:30 - 5:30 PM** | **Session VII Continued (moderator: Scoville)** |

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| Davé | The Odd Meanderings of the IMF Across Cosmic Time |
| Murphy | The Possibility of Identifying Variations to the IMF at High-z Through Deep Radio Surveys |

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| **5:30 - 6:15 PM** | **Review Panel Member Meeting (Manzanita room)** |
| **7:00 - 9:00 PM** | **Banquet (Village Terrace)** |

## Friday, June, 25th

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| **9:00 - 11:00 AM** | **Brunch (Agave room)** |

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| Calzetti (**chair**), Ferguson, Gallagher, Krumholz, Scoville, Pflamm-Altenberg | Review Panel / Group Discussion |

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| **11:15 AM** | **Adjourn Workshop** |

## Poster Presentations

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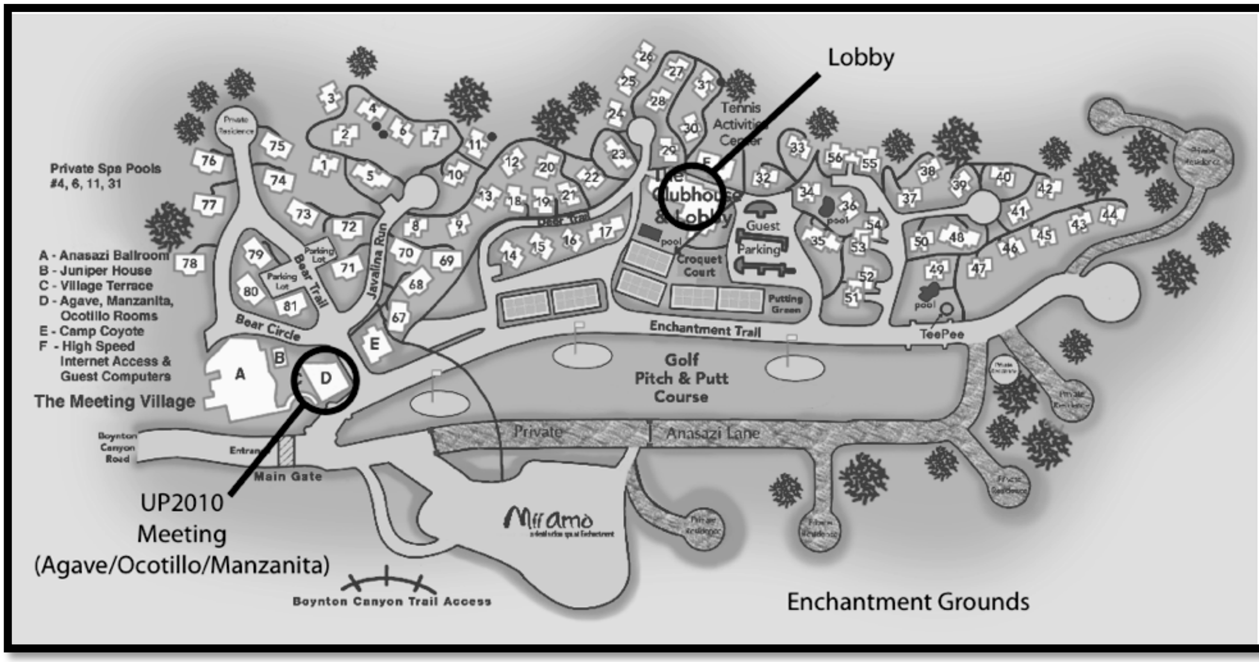
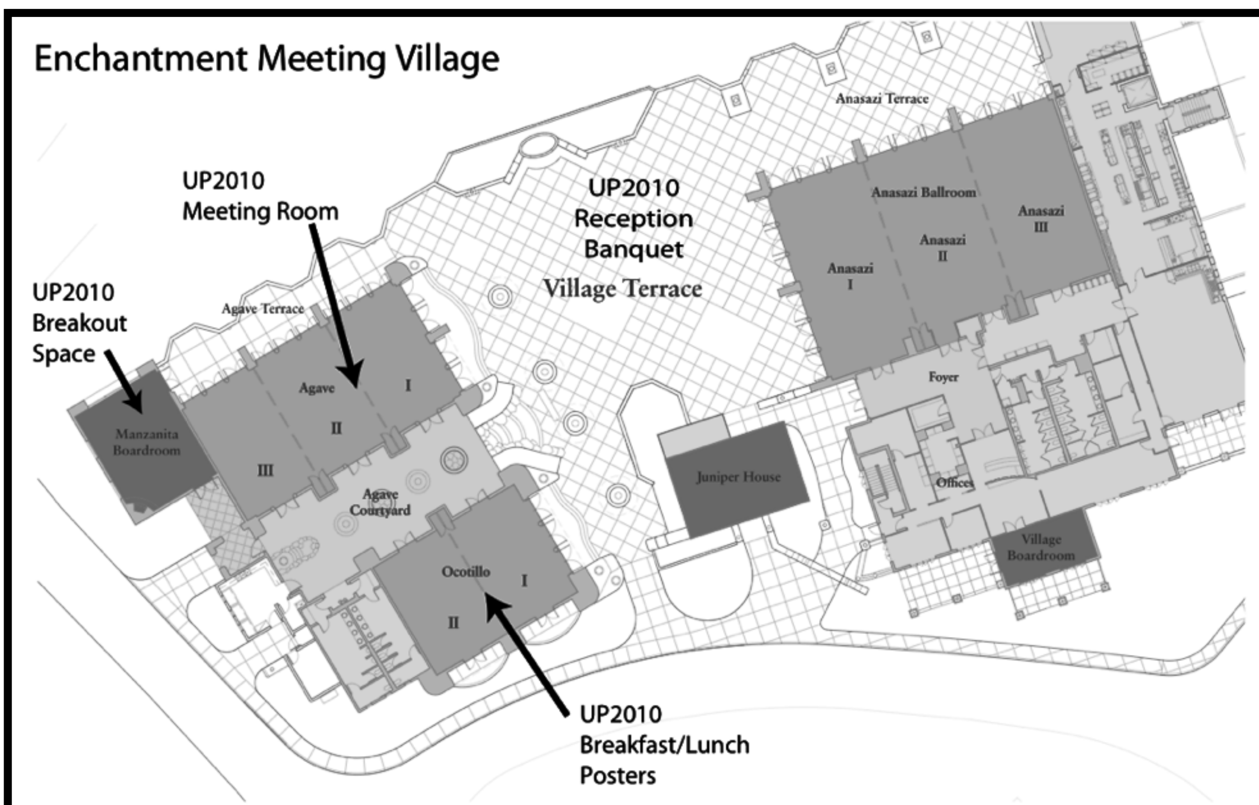
| Donovan Meyer | Star Formation in the Outskirts of Early Type Galaxies |
| Fumagalli | SLUG: A new way to Stochastically Light Up Galaxies |
| Giavalisco | Star Formation in Massive Galaxies at Redshift 2<4 |
| Hsu | Competitive Accretion in Sheet Geometry and the Stellar IMF |
| Kim | Study of Resolved Stellar Populations in M83 using HST/WFC3 Early Release Science Data |
| Pflamm-Altenberg | Accretion-regulated star formation in galaxies |
| Urban | Studying the effect of radiation and dust-gas energetics on clustered star formation |
| Watson | Testing the Star Formation Law in Bulgeless Disk Galaxies |
| Wofford | The Massive Star Initial Mass Function of Circumnuclear Clusters in M83 |
| Wyder | H-alpha and UV imaging of XUV disks and LSB galaxies |
| Zahid | The MZ and LZ relation from DEEP2 at z ~ 0.8 |
| Zhang | Population Analysis of the LITTLE THINGS Sample |

# Meeting and Events Space

The opening reception and workshop registration will be held on the Village Terrace of the Meeting Village conference center. Talks and discussion will take place in the Agave meeting room. Continental breakfast and buffet lunch will be served in the Ocotillo room. Posters will also be displayed in the Ocotillo and/or the Agave room. The Manzanita boardroom is available to host any breakout sessions or working groups. Weather permitting, the banquet will be held outdoors on the Village Terrace; otherwise, it will be held in the Ocotillo room.



# Proceedings

Proceedings for the UP2010 Conference will be published in hardcover in the Astronomical Society of the Pacific Conference Series (ASPCS). Every effort will be made to deliver the proceedings to you within 6 months.

## Deadline:

All contributions are **due by Friday, August 6, 2010.**

## Space Limits:

Articles based on talks may be up to 8 pages and articles based on posters may be up to 4 pages.

## Template Package:

Obtain the required templates, style files, instructions/guidelines and examples from the meeting website: http://up2010.obs.carnegiescience.edu/proceedings

The template package contains:

1 up2010_template.tex : the latex template file.
2 up2010_fig1.eps and up2010_fig2.eps : 2 figures used in the template.
3 up2010_ref.bib : the bibliographic template file.
4 up2010_template.pdf: the lateXed template in pdf format.
5 asp2010.sty : the ASP latex style file.
6 asp2010.bst : the ASP bibliographic style file.
7 manual2010_authors.pdf : the ASP instruction manual (note that we have modified and renamed the ASP template files aspauthor.tex and author.bib to include examples of figures and references).
8 copyrightform.pdf : the copyright form (to be signed and returned to us in Sedona).
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10 checklist.pdf : the check list to be completely fulfilled before submitting your contribution.
11 README : this information

## Rules and Tips:

Please follow the author instructions carefully and do not change the macros or add in your own definitions or latex packages (including old asp packages), any changes will be ignored when compiling the volume!

Space management tools such as \vspace commands will be removed, please don't use them.

Figures must be in .eps format with a resolution > 266 ppi (pixels per inch). Bear in mind that line diagrams must be of a suitably higher resolution (e.g., 800 ppi) to avoid pixelation.

Figures will appear in black & white, make sure to describe them appropriately in your captions.

Please use \plotone or \plottwo unless \plotfiddle is absolutely necessary.

For those unfamiliar with BibTeX, the entries in BibTeX format to be included in your *.bib file can be obtained from the ADS.

To compile your article on the command line:

```
> latex up2010_template
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> latex up2010_template
> dvips -Ppdf up2010_template.dvi
> ps2pdf14 up2010_template.ps
```

Do not worry about missing the ncccropmark.sty and watermark.sty files.

TeXShop does steps 5 and 6 automaticallly but you will still need to run latex several times to generate the references and figure numbers.

## Submission:

Please deliver your proceedings contributions as a gzipped tarfile via anonymous ftp:

```
> ftp ftp.obs.carnegiescience.edu
> Username: anonymous
> Password: your email address
> cd up2010
> put lastname_firstinitial.tar.gzip
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1. Manuscript [lastname_firstinitial.tex] using the up2010_template.tex template.
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Please proof-read your contribution thoroughly before submission. Your utmost care in following the guidelines is crucial if we are to meet our ambitious plan to deliver these proceedings to you in 6 months!

# Talk Abstracts
**(chronological)**

Dr. Hans Zinnecker AIP Potsdam and Sofia Science Center

## The upper end of the IMF: an UP2010 introductory review

In this opening talk for the UP2010 conference, we shall discuss various models of high-mass star formation and their predictions for the upper stellar mass limit and the slope of the upper IMF. We also plan to theorize to what extent the upper mass limit and the slope of the upper IMF are correlated or can vary independently. Observational tests will be suggested to discriminate between these possibilities.

| Dr. | Cathie | Clarke | Institute of Astronomy, Cambridge |
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## The maximum stellar mass in clusters: evidence from observations and hydrodynamical simulations

I shall review observational compilations of the maximum stellar mass as a function of cluster richness and will argue that observational data is inconclusive as to whether the data is compatible with random sampling or with a systematic dependence of maximum mass on cluster size. This is partly due to the fact that the data is skewed by the way that objects are selected in observational surveys and partly because the level of scatter expected from random sampling means that it is hard to discern unambiguous systematic effects without an unrealistically large sample. I will also report on recent analyses of hydrodynamical simulations which shed some light on the shaping of the upper IMF. In these calculations (which presently omit feedback) there is good evidence that the upper IMF is not a single power law but shows evidence for truncation. In the simulations this bunching of stellar masses at the upper end is a result of a similar mass acquisition history for a small group of stars that form early in the simulation. I will conclude that the issue of IMF truncation in observed systems is better served by a proper statistical analysis of the upper IMF over a reasonable range of stellar mass, rather than by maximum stellar mass data alone; given that the statistical tools for testing for truncation are well developed, the outstanding issue becomes one of accurate mass determinations for large samples of early type stars.

Dr. Carsten Weidner University of St Andrews

## The galaxy-wide IMF - from star clusters to galaxies

Over the past years observations of young and populous star clusters have shown that the stellar IMF appears to be an invariant featureless Salpeter power-law with an exponent alpha = 2.35 for stars more massive than a few Msol. A consensus has also emerged that most, if not all, stars form in stellar groups and star clusters, and that the mass function of young star clusters can be described as a power-law with an exponent beta approx. 2. These two results imply that the integrated galactic-field IMF (IGIMF) for early-type stars cannot be a Salpeter power-law, but that they must have a steeper exponent. This has important consequences for the distribution of stellar remnants and for the chemo-dynamical and photometric evolution of galaxies.

Dr. Phillip Massey Lowell Observatory

## What the Stellar Content of OB Associations Tell Us (and Not) About the Slope of the IMF and Upper Mass Cutoffs

The advent of CCD spectrometers on large aperture telescopes allow us to obtain complete censuses of massive stars in OB associations and clusters throughout the Local Group. Such studies allow us to measure the degree of coevality of such regions, and to compute an IMF slope, as well as to look for evidence of a physical upper mass limit. I will review the data in hand, and give my own views on what these data do (and don't) tell us.

Dr. Fernando Selman European Southern Observatory

## Around the Tarantula and into the Arches: a Salpeter IMF in the field and in clusters.

The stellar IMF research that our group has conducted in the field and cluster area of the Tarantula nebula will be presented together with our latest work in the Arches cluster near the galactic center. We propose that the ionizing cluster of the Tarantula has the best determined stellar IMF and should define what we call Salpeter. We also show that there is no contradiction in principle to have the same stellar mass function in clusters and in the field population independently of what the cluster mass function is.

Dr. Fernando Comeron European Southern Observatory

## RCW 108: Massive star formation in a nearby troubled environment

At 1.3 kpc from the Sun, RCW 108 is the region hosting the latest star forming episode of the extended Ara OB1 association. It is also one of the most promising examples where triggered star formation may be going on at present. The trigger is the nearby cluster NGC 6193, which is clearly eroding a molecular cloud producing a bright, rim-shaped HII region. The most prominent star forming site in RCW 108, IRAS 16362-4845, is a compact HII region embedded in the molecular cloud where infrared images reveal a moderately rich cluster. Deep, adaptive-optics-assisted imaging of this cluster shows its weird appearance, characterized by a marked scarcity of faint members and a lack of central concentration of its brightest stars. A detailed analysis of the near-infrared spectral energy distribution of the cluster members confirms that the IRAS 16362-4845 is characterized by a top-heavy stellar mass function, with a very shallow slope that extends all the way from the most massive, late O-type stars of the cluster down to subsolar masses. Given the peculiar environment in which IRAS 16362-4845 resides, it is tempting to relate the unusual features of its embedded stellar population to the injection of energy from the most massive members of the neighboring NGC 6193 into its parental cloud. This supports the view that star formation in heavily disturbed environments tends to give rise to unusual stellar mass functions dominated by massive stars, and provides a nearby example where the outcome can be observed in remarkable detail.

| Dr. | Andrea | Stolte | University of Cologne |
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## Clusters near the center of the Galaxy - how weird is their IMF?

It has been argued on theoretical grounds that the IMF in the hot, UV-rich Galactic center environment might be biased to high-mass stars. Several studies made the attempt to derive the stellar mass function in Galactic center starburst clusters, as well as in the nuclear cluster itself. While there is indirect evidence for an overproduction of massive stars, which may indicate a top-heavy IMF, the direct observations of the MF are subject to large uncertainties, such as field contamination, age and distance estimation, cluster membership, etc. Especially the problem of field contamination and membership determination has become more accessible with high-angular resolution proper motion studies of Galactic center starburst clusters. Given the large stellar densities observed along the line of sight towards the GC, proper motion membership studies allow realistic estimates of the present-day MF for the first time. Yet, dynamical evolution also alters the appearance of the IMF and has to be considered when progressing from the present-day MF to the IMF. First results from the starburst cluster proper motion campaign will be presented to display the effects of field star contamination in the dense GC environment, and the biasing observational effects on the IMF and possible solutions will be presented to raise discussion among the audience.

Ms. Katharine Johnston CfA / Universty of St. Andrews

## Probing the origin of the IMF in regions of massive star formation

In this talk I will present results from our survey of ionized gas at 3.6 cm towards 31 intermediate- and high mass clumps detected in previous millimeter continuum observations (Johnston et al. 2009). With these observations, we have studied the relationship between the star forming gas, traced by millimeter continuum emission from dust, and the ionized gas created by massive stars. Our results suggest there is a relationship between the observed clump mass and the mass of the ionizing massive stars within it, which is consistent with a power law. This result is comparable with a similar relationship found between the maximum stellar mass in young clusters and the total cluster mass (e.g. Larson 2003 and Weidner et al. 2009), suggesting that this relationship is set early-on in the history of the cluster by the amount of available star forming gas. I will also present preliminary results using a larger sample of compact HII regions embedded in molecular clouds, to investigate whether at high masses this relationship diverges from the simple power law expected when stars are drawn from a canonical IMF - an effect that may be due to stellar feedback.

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| Dr. | Jessica | Lu | Caltech |

## Mass Functions for Young Starburst Clusters in Different Milky Way Environments

We present results from observations of several massive (>10^4 Msun), young star clusters both in the disk and nucleus of our Galaxy. Using Keck laser guide star adaptive optics, we obtain high-precision proper motions to identify individual cluster members and construct mass functions from multi-color, near-infrared photometry. The mass functions for these clusters are compared to search for environmental dependences.

Prof. Sally Oey University of Michigan

## OB Stars in Stochastic Regimes

The highest-mass stars have the lowest frequency in the stellar IMF, and they are also the most easily observed stars. Thus, the counting statistics for OB stars provide important tests for the fundamental nature and quantitative parameters of the IMF. We first examine some local statistics for the stellar upper-mass limit itself. Then, we examine the parameter space and statistics for extremely sparse clusters in the SMC that contain OB stars. We find that thus far, these locally observed counting statistics are consistent with a constant stellar upper-mass limit. We also discuss whether clusters are distributed fundamentally by mass, or by cluster membership number.

Dr. Jorick Vink Armagh Observatory

## How massive is the most massive star?

The current masses found for the most massive stars in clusters depend heavily on the mass-loss history since birth. I will present the latest mass-loss predictions for the most massive stars in our Universe (in the mass range 60-300 solar masses) using a novel hydrodynamic method that includes the important effects of multiple photons interactions, predicting the rate of mass loss and the wind terminal velocity simultaneously. I will subsequently discuss the controversial issue of whether one would theoretically expect there to be an upper mass limit, and whether this should be metallicity dependent.

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| Dr. | Mark | Krumholz | UC Santa Cruz |

## How Does Radiation Feedback Affect Fragmentation and the IMF?

I discuss the results of recent radiation-hydrodynamic simulations of the formation of stars and star clusters, with primary focus on how radiation feedback affects fragmentation and the mass function of the resulting stars. I show that radiation feedback strongly affects how gas fragments, and that this effect favors the formation of more massive stars in regions of high surface density. I discuss the implications of this result for studies of the IMF.

| Dr. | Rowan | Smith | Institut für Theoretische Astrophysik - Universität Heidelberg |
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## Can environmental conditions affect the upper end of the IMF?

The shape of the stellar initial mass function (IMF) is an important ingredient in our attempts to model the evolution of the Universe through cosmic time. Typically the form of the IMF is assumed to follow a universal power-law, roughly consistent with the value originally proposed by Salpeter. However the exact form of the IMF is still under debate and in particular, the question still remains open as to whether the IMF depends on the environmental conditions within particular star forming regions. We present recent numerical work that starts to address how the physical and environmental conditions within star-forming regions can influence both the mass function of clusters, and the stellar mass function inside these clusters. Rather than adopting a prescribed equation of state for the gas, we model the main heating and cooling processes directly. In our first set of calculations we focus on how the build-up of clusters and the properties of the stars within them, and in particular the massive stars, are influenced by the metallicity of the gas and the strength of the interstellar radiation field. We shall then examine how the massive end of the IMF is constructed from the gas in a simulated GMC by directly tracing the link between bound cores and the stellar IMF. The collapse of cores to form stellar systems proceeds highly anisotropically, and accretion is primarily along dense filaments. This means that the evolution of the core mass function to the IMF depends on environmental conditions and core geometry in addition to the core masses. We show that for massive stars, accretion from diffuse "clump" gas is the dominant contribution to the final stellar mass. This suggests that the properties of the entire cluster-forming region are important when setting the upper end of the IMF.

| Prof. | Nick | Scoville | Caltech |
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## Determining the Upper End Requires Knowing the Lower End

Measuring variations at the high mass end requires knowing the low mass end since these are always relative to the mass of low mass stars. I discuss a new observational constraint on the low mass end which when seen requires significant masses of stars down to ~1 Msun.

Tuesday AM

| Dr. | Edvige | Corbelli | INAF-Osservatorio di Arcetri |
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## The Cluster Birthline and the formation of stellar clusters in M33

A new method to analyze the IMF at the high mass end in Young Stellar Clusters is presented. Its applicability rely on the determination of the bolometric luminosity of the newly born clusters which is usually done through multi-wavelength Spectral Energy Distribution analysis, using accurate photometry and appropriate theoretical spectral models.

Prof. Daniela Calzetti University of Massachusetts Dept. of Astronomy

## A New Approach to Measuring the Stellar IMF

We present a method for investigating variations in the upper end of the stellar Initial Mass Function (IMF) by probing the production rate of ionizing photons in unresolved, compact star clusters with ages < 10 Myr and with different masses. We test this method on the young cluster population in the nearby galaxies NGC5194 (M51a) and NGC5236 (M83), for which multi--wavelength observations from the Hubble Space Telescope are available. Our results indicate that the proposed method can probe the upper end of the IMF in galaxies located out to at least ~10 Mpc, i.e., a factor ~200 further away than possible by counting individual stars in young compact clusters. Our results for the two galaxies show no obvious dependence of the upper mass end of the IMF on the mass of the star cluster, down to ~1000 M_sun, although more extensive analyses involving lower mass clusters and other galaxies are needed to confirm this conclusion.

Tuesday AM

Dr. Miguel Cerviño IAA-CSIC

## From CMDs to Integrated properties: Probabilistic synthesis models

In this contribution I would present a probabilistic synthesis model approach that connect smoothly CMD analysis with the integrated properties of stellar systems. This approach allows to explain/evaluate size-of-sample effects in the inference of M_up in both resolved and non-resolved stellar systems. It allows allows one to evaluate the amount of information that would be obtained from single observations and provides a framework to study large samples of stellar systems. In the talk I will focus on the inference of M_up of the IMF, in particular the size-of-sample with fixed M_up vs M_up(Mcl) dichotomy. I also investigate the relevance of the ICMF in both the integrated light and chemical evolution of galaxies.

| Dr. | Hans | Zinnecker | AIP Potsdam and Sofia Science Center |
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## The Chances of Massive Star Collisions in the Center of the R136 Cluster Core

The observed stellar number density of massive stars in the center of the dense core of the R136 cluster in the LMC is high enough to enable stellar collisions to occur within the short Main-Sequence lifetime of very massive stars (100 Mo). This has implications for the uppermost IMF and its relation to gamma ray burst progenitors.

Dr. Brad Whitmore STScI

## Luminous Stars in Galaxies Beyond 3 Mpc

I am mainly interested in the formation and destruction of young star clusters in nearby star forming galaxies such as the Antennae, M83, and M51. One of the first analysis steps is to throw out all those pesky stars that keep contaminating my young cluster samples. Recently, spurred on by our new WFC3 Early Release Science data of galaxies including M83, NGC 4214, M82, NGC 2841, and Cen A, we began taking a closer look at the stellar component. Questions we are addressing are: 1) what are the most luminous stars, 2) how can we use them to help study the destruction of star clusters and the population of the field, 3) what fraction of stars, at least the bright stars, are formed in the field, in associations, and in compact clusters.

| Dr. | Dan | Weisz | University of Minnesota |
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## Constraints on the Field Star IMF from Resolved Stellar Populations based Star Formation Histories

Using HST/ACS observations of resolved stellar populations in nearby galaxies (e.g., ANGST, LCID), I explore the constraints one can place on the field star IMF from star formation histories (SFHs) derived from synthetic color-magnitude diagram (CMD) fitting. In particular, I show how reasonable variations in the slope of the IMF, relative to a Salpeter slope, lead to only minor changes in the SFHs. This shows that CMD-SFH fitting parameter space has a broad minimum with respect to IMF variations and implies that CMD based SFHs can only provide weak constraints on the stellar IMF. Further, I demonstrate how other uncertainties, e.g., metallicities, isochrone degeneracies, in the CMD based SFH fitting process also pose a challenge to measuring the effects of variations in the IMF.

| Dr. | Janice | Lee | Carnegie Institution for Science |
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## UV/H-alpha Turmoil

The UV capabilities of GALEX have revealed that there may be more star formation in low-density environments than previously recognized. Until GALEX, a great deal of our understanding of star formation in the local universe had been based on H-alpha observations, but recent studies have shown that the H-alpha luminosity appears to underestimate the star formation rate in dwarf and low surface brightness galaxies, as well as in the extended disks of spirals. I will present a study using a complete sample of ~300 spiral and irregular galaxies in the 11 Mpc Local Volume, that establishes this systematic trend with a significant sample of dwarf galaxies with SFRs from 0.1 Msun/yr down to 0.0001 Msun/yr. Such trends have been cited by some as evidence that the stellar initial mass function is deficient in high-mass stars in low-density environments. I discuss this and a range of other explanations.

Prof. Gerhardt Meurer University of Western Australia/JHU

## Upper-End IMF Variations Deduced From HI Selected Galaxies

Since H-alpha traces the presence of ionizing UV emission, which requires O stars (M* > 20 Msun), and vacuum UV emission traces the presence of both O and B stars (M* > 3 Msun), the flux ratio H-alpha/FUV strongly depends on the IMF. I will show how our H-alpha/FUV results from the SINGG and SUNGG surveys indicates that the IMF is variable, depending primarily on stellar mass density. Alternative interpretations of our results will be critically examined. I will also show recent work by our team on local H-alpha/FUV variations within galaxies.

Dr. Alessandro Boselli Laboratoire d'Astrophysique de Marseille France

## High Mass Star Formation in Normal Late-Type Galaxies: Observational Constraints to the IMF

We use H-alpha and far-ultraviolet (FUV, 1539 Ang) GALEX data for a large sample of nearby objects to study the high mass (m > 2 Msun) star formation activity of normal late-type galaxies. The data are corrected for dust attenuation using the most accurate techniques at present available, namely the Balmer decrement for H-alpha data and the total far-infrared to FUV flux ratio for GALEX data. The sample shows a highly dispersed distribution in the H-alpha to FUV flux ratio (Log f (H-alpha)/f (FUV)) = 1.10 ± 0.34 indicating that two of the most commonly used star formation tracers give star formation rates with uncertainties up to a factor of 2-3. The high dispersion is partly due to the presence of AGN, where the UV and the H-alpha emission can be contaminated by nuclear activity, highly inclined galaxies, for which the applied extinction corrections are probably inaccurate, or starburst galaxies, where the stationarity in the star formation history required for transforming H-alpha and UV luminosities into star formation rates is not satisfied. Excluding these objects, normal late-type galaxies have Log f (H-alpha)/f (FUV) = 0.94 ± 0.16, which corresponds to an uncertainty of ~50% on the SFR. The H-alpha to FUV flux ratio of the observed galaxies increases with their total stellar mass. If limited to normal star forming galaxies, however, this relationship reduces to a weak trend that might be totally removed using different extinction correction recipes. In these objects the H-alpha to FUV flux ratio seems also barely related with the FUV-H colour, the H band effective surface brightness, the total star formation activity and the gas fraction. The data are consistent with a Kroupa (2001) and Salpeter initial mass function in the high mass stellar range (m > 2 Msun) and imply, for a Salpeter IMF, that the variations of the slope alpha cannot exceed 0.25, from alpha = 2.35 for massive galaxies to alpha = 2.60 in low luminosity systems. We show however that these observed trends, if real, can be due to the different micro history of star formation in massive galaxies with respect to dwarf systems.

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| Dr. | David | Thilker | The Johns Hopkins University |

## The role of extended ultraviolet disk (XUV-disk) galaxies in the IMF controversy

The recognition of spatially extended ultraviolet disks (XUV disks) in nearly 30\% of nearby spiral galaxies partially motivated recent considerations of a variable upper IMF. Particularly intriguing are the XUV-disks which do not exhibit a comparably extended distribution of HII regions. We review our observational understanding of the XUV-disk phenomenon, based on a comprehensive GALEX survey of 3000+ local galaxies which examines early-type galaxies as well as spirals. One aim was to compile a statistically-significant reference sample of XUV-disk UV-emitting complexes for which the distribution function of L(H-alpha)/L(UV) could be measured and then compared with predictions from cluster population models incorporating stochasticity and genuine IMF variability. If time allows, we will also discuss HST UV-optical analysis of selected XUV-disks.

Dr. John Eldridge Institute of Astronomy University of Cambridge

## How star-formation rate indicators vary with the IMF and how it is sampled.

To gain understanding from observations of stellar populations in galaxies theoretical models are required. Using our state-of-the-art and highly adaptable binary population and spectral synthesis code (BPASS) we are able to produced detailed models for comparison to observations. Importantly these models for the first time included detailed binary models so that the varied effects of binary evolution are implicitly included in our model stellar populations and spectra. We will present our latest results on how varying the IMF, and more importantly how it is sampled, effect observable details of stellar populations in star-forming galaxies. We take the example of the ratio of the star-formation rates estimated from the H(alpha) line and from the FUV flux. We find that the trend in the mean value and scatter around the mean can provide some indication on how the IMF is sampled. Currently the best match is found when the IMF is sampled randomly rather than there maximum mass of a star in a cluster being dependent on the mass of the cluster however further study is required to prove this conclusively. We will also briefly summarize other comparisons between BPASS models and observations that provide similar constraints and insight.

Dr. Benjamin Johnson Institute of Astronomy

## Fitting the UV through IR SED of Galaxies in the Local Volume

The distribution of the Halpha/UV ratio in local, low-luminosity galaxies is suggestive of a varying high-mass IMF, though several additional effects may be responsible. I will describe the types of star formation history (SFH) and dust attenuation distributions that are required to explain these ratios -- as well as the UV through IR spectral energy distribution -- under the assumption that the IMF does not vary. This is accomplished through the quantitative comparison of the observed integrated SED and Halpha/UV ratios of nearby galaxies to large suites of stellar population synthesis (SPS) models. These SPS models include bursts of star formation and far-infrared emission from dust. The sample of galaxies that I will consider is drawn from the Local Volume Legacy Survey which obtained UV (GALEX), H-alpha, and IR (Spitzer) observations of a magnitude limited sample of galaxies within 11Mpc. In addition to describing the physical properties (including stellar mass, metallicity, and dust attenuation) of the Local Volume galaxies thus obtained, I will consider additional independent lines of evidence to assess whether the SFHs required by SPS modeling with a universal IMF are a viable possibility for low-luminosity, nearby galaxies.

| Dr. | Erik | Hoversten | Penn State |
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## Evidence for IMF Variations from the Intergrated Light of SDSS Galaxies

We present an extension of the Hoversten & Glazebrook (2008) study of the IMF in a sample of 130,000 actively star forming galaxies in the Sloan Digital Sky Survey (SDSS). H alpha equivalent widths (EW) are compared to broadband colors, following Kennicutt (1983), and H delta absorption measurements to constrain the IMF within the 3" SDSS apertures which contain on average 25% of the total light from the galaxies. In this parameter space the effects of the age of the stellar population are largely orthogonal to those of the IMF and the effects of metallicity are small compared to IMF variations. We find that for luminous galaxies the agreement with a universal IMF is good. However, low luminosity galaxies appear to exhibit IMF variations above what can be attributed to systematics. We show similar variations as a function of r-band surface brightness, where low surface brightness galaxies are deficient in massive stars. Finally, we show that at fixed luminosities IMF variations as a function of surface brightness persist, as well as vice versa.

Mr. Joerg Dabringhausen University of Bonn

## Top-heavy IMFs in ultra-compact dwarf galaxies?

Ultra compact dwarf galaxies (UCDs) are dense stellar systems at the border between massive star-clusters and small galaxies. The perhaps most remarkable finding about them is that their average optical mass-to-light (M/L) ratio cannot be explained by stellar populations with the canonical stellar initial mass function (IMF). It seems likely from this perspective that UCDs have non-canonical IMFs, since it is doubtful that non-baryonic dark matter can accumulate enough on the scales of UCDs for influencing their dynamics significantly. In aged stellar systems like the UCDs, a top-heavy IMF could however provide unseen mass by an abundance of stellar remnants. Such a variation of the IMF can be understood if UCDs represent a case of rapid star-formation in an extremely dense environment. While top-heavy IMFs imply a much heavier mass-loss shortly after the formation of a stellar system, this process does not necessarily dissolve the UCDs. Their formation with a top-heavy IMF would therefore not contradict their existence.

Dr. Jan Pflamm-Altenburg AIfA Bonn

## Applications of the IGIMF-theory

The functional form of the galaxy-wide stellar initial mass function is of fundamental importance for the transformation of observational quantities into physical quantities of galaxies. So far this galaxy-wide stellar initial mass function has been assumed to be identical to the stellar initial mass function (IMF) observed directly in star clusters. But the nature of clustered star formation, i.e. stars form predominantly in compact star clusters rather than uniformly distributed over the whole galaxy, requires the galaxy-wide IMF to be calculated by adding all IMFs of all young star clusters. This integrated galactic stellar initial mass function (IGIMF) is steeper than the canonical IMF in star clusters and steepens with decreasing SFR, leading to fundamental new insights and understanding of star forming properties of galaxies. In this talk I will summarize all applications of the IGIMF-theory made so far, and present new possibilities to test its validity.

Dr. Bruno Jungwiert Astronomical Institute ASCR - Prague

## N-body simulations of disk galaxies with long-term stellar mass-loss within the IGIMF framework

We present N-body/gas-dynamical simulations of disk galaxies aimed at quantifying the IGIMF effect combined with the long-term stellar mass-loss from low-mass and intermediate-mass stars on galaxy dynamics, star formation rate, stellar build-up and gas depletion time-scales as well as on abundance gradients.

Wednesday PM

Dr. Francesco Calura INAF- Oss. di Trieste/Univ. Central Lancashire

## The Role of the IGIMF in the chemical evolution of the solar neighbourhood

We test the effects of the integrated galactic initial mass function (IGIMF) on the chemical evolution of the solar neighbourhood. The IGIMF (Weidner & Kroupa 2005) is computed from the convolution of the stellar initial mass function (IMF), i.e. the mass function of single stars, and the embedded cluster mass function, i.e. a power law with index beta. By taking into account also the fact that the maximum achievable stellar mass is a function of the total mass of the cluster, the result of the convolution is a time-varying IMF which depends on the star formation rate. We applied this formalism to a chemical evolution model for the solar neighbourhood and compared the results obtained by assuming three possible values for beta with the results obtained by means of a standard, well-tested, constant IMF. In general, a lower absolute value of beta implies a flatter IGIMF, hence a larger number of massive stars and larger metal ejection rates. This translates into higher Type Ia and II supernova rates, higher mass ejection rates from massive stars and a larger amount of gas available for star formation, coupled with lower present-day stellar mass densities. Lower values of beta correspond also to higher metallicities and higher [alpha/Fe] values at a given metallicity. We consider a large set of chemical evolution observables and test which value of beta provides the best match to all of these constraints. We also discuss the importance of the present day stellar mass function (PDMF) in providing a way to disentangle among various assumptions for beta. Our results indicate that the IGIMF computed with beta=2 should be considered the best since it allows us to reproduce the observed PDMF and to account for most of the chemical evolution constraints considered in this work.

| Prof. | Pavel | Kroupa | Argelander Institute for Astronomy Bonn |
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## Some implications of the variable galaxy-wide IMF

The integrated galactic initial mass function (IGIMF) results from adding the IMFs in all forming star clusters in a galaxy. The IGIMF turns out to be deficient in massive stars, and the deficiency increases for galaxies with lower star-formation rates. Since massive stars are usually the tracers of current star-formation activity in a galaxy, the star-formation rates need to be revised. I will discuss the star-formation behaviour of galaxies within the IGIMF framework which may have some interesting implications for fundamental physics.

Dr. Barry Madore Carnegie Observatories

## What Is This Thing Called the Schmidt Law?

In an extragalactic context the Schmidt Law began as a very simple power-law description of how current high-mass star formation scales with coincident and contemporary neutral hydrogen surface density. On the other hand theorists often use the Schmidt Law formalism as a simplified means of modeling the sensitivity of future star formation to present total gas volume density. Subsequent generalizations from a local Schmidt Law to a global one has added a layer of complexity that has not been fully appreciated or completely explored. We will attempt to make explicit and then reconcile these various views of what the Schmidt Law is. And then we will explore how the Schmidt Law can best be calibrated and used, by presenting a combination of simple mathematical models, computer simulations and new data from space (GALEX) and the ground (THINGS). The tracers of high-mass star formation and their various timescales figure prominently in this analysis.

Miss Madusha Gunawardhana Macquarie University Sydney

## The dependence of the stellar initial mass function on the galaxy star formation rate

Recent studies based on non-traditional approaches (e.g., integrated properties of large samples of galaxies, carbon-enhanced metal-poor stars) have suggested a non-universal IMF that varies between galaxies and possibly evolves with time. The study of the implications of an evolving or spatially variable IMF, and possible observational approaches to constraining this quantity, is fundamental to a broad range of galaxy evolution research. I will present the results of a study conducted using GAMA (Galaxy And Mass Assembly) spectroscopic data that show a strong underlying IMF dependency on the SFR of the host galaxy, indicating that high star formation rate systems are characterized by a shallow IMF slope. This result is shown to be robust against a variety of potential instrumental and sampling biases. It is supported by, and provides an explanation for, the results of numerous recent explorations implying a variation or evolution in the IMF.

| Dr. | Claus | Leitherer | STScI |
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## Constraints on the Upper IMF from Ultraviolet Spectral Lines

Stellar-wind lines in the ultraviolet are an indicator of recent massive star formation and are sensitive to the IMF of the most massive stars. I will discuss the behavior of some of the key lines and how they are affected by the degeneracy between IMF, age, and metallicity. I will give examples of observations of nearby and distant galaxies and evaluate whether there is evidence for a variable IMF.

| Dr. | James | Neill | Caltech |
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## Measuring the Upper End of the IMF with Supernovae

Supernovae arise from progenitor stars occupying the upper end of the initial mass function. Their extreme brightness allows individual massive stars to be detected at cosmic distances, lending supernovae great potential as tracers of the upper end of the IMF and it's evolution. Exploiting this potential requires progress in many areas of supernova science. These include understanding the progenitor masses that produce various types of supernovae and accurately characterizing the supernova outburst and the environment in which it was produced. I will present some recent work identifying the environmental conditions that produce the most luminous supernovae, believed to arise from stars with masses greater than 100 solar masses. I will use the presence of these extreme supernovae in small star-forming dwarfs to test our understanding of the upper end of the IMF.

| Dr. | Jeff | Cooke | Caltech |
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## Type IIn supernova detections in z ~ 2 Lyman break galaxies: Probing the IMF directly

Type IIn supernovae (SNe IIn) exhibit extremely luminous ultraviolet continua during outburst and extremely luminous, long-lived narrow ultraviolet and optical emission lines. These properties have enabled successful high redshift detections in archival imaging and late-time spectroscopic confirmation and study. I will present our method of detecting $z > 2$ SNe IIn and the first 6+ spectroscopic confirmations at $2 < z < 3$ using the Canada-France-Hawaii Telescope Legacy Survey and the Keck Telescopes. Because SNe IIn are believed to have massive progenitors, the well-defined volume and well-understood host galaxy population surveyed using this method facilitate a direct test of the high-mass end of the high-redshift IMF from a relatively small number of detections. I will discuss the implications of the current detections on the form of the IMF and the enhancement of these results from $2 < z < 6$ via upcoming large, deep synoptic surveys such as Hyper SuprimeCam, the LSST, and future 30m-class telescopes.

| Mr. | Loïc | Le Tiran | GEPI Observatoire de Paris |
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## The turbulent ISM of galaxies about 10 Gyrs ago: an impact on their IMF?

I will present observations of 10 massive galaxies as seen as they were 9 Gyrs ago with the integral-field spectroscopy using SINFONI from the ESO-VLT, combined with data obtained from the DEEP2 Survey. I will first paint a brief picture of the physical conditions at work in these galaxies: they exhibit complex morphologies, high star formation and are so pressure dominated they are likely to drive winds. Moreover, their ratio of Hα to FUV flux to R-band luminosity surface brightnesses indicates that perhaps their initial mass function is flatter than Salpeter at the high mass end, as has been suggested recently for some local galaxies. It may be that high turbulence is responsible for skewing the IMF towards more mass stars as has been suggested by some theories of star-formation.

Mr. Chris Hayward Harvard-Smithsonian Center for Astrophysics

## The IMF in z~2 Starbursts: Evidence for Minimal Variations from Local Mass Functions

Matching the observed abundance and redshift distribution of submillimeter galaxies (SMGs), some of the most luminous, rapidly star-forming galaxies in the Universe, has been a notorious problem for galaxy formation models. Typically, solutions to this problem have required ad hoc IMF variations at high redshift, ranging from a "bottom-light" IMF (Dave et al. 2009) to the extreme "flat" IMF (Baugh et al. 2005). I will argue that significant IMF modifications are not justified by the apparent conflict between observed SMG number counts and those predicted by previous models. I will present a multi-scale model for the formation of SMGs which can accurately reproduce the observed UV-mm wave SED, inferred physical properties, and observed number counts of this population. Our model, the first to combine high-resolution N-body/hydrodynamic simulations and dust radiative transfer in a cosmological framework, is able to match observed 850 micron number counts even while utilizing a "standard" Kroupa IMF.

| Mr. | Stephen | Wilkins | University of Oxford |
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## The Effect of an Evolving IMF on the Cosmic Star Formation History

It has been noted by several studies that the integral of the cosmic star formation history (CSFH) suggests a local stellar mass density discrepant with in-situ observations. One potential solution for this is the IMF: either through an alternative universal IMF of some form of IMF evolution. The latter of these is particularly interesting due to tentative recent evidence of IMF variation and the implications for galaxy formation and evolution. In this talk the effect of the IMF on the CSFH, the build up of stellar mass density and the cosmic spectral energy distribution will be discussed.

| Dr. | Naveen | Reddy | NOAO |
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## Reconciling the Star Formation and Stellar Mass Density Histories

I will review some recent work on quantifying the systematics inherent in star formation and stellar mass density estimates at high redshift, including luminosity-dependent dust corrections and an accounting of the stellar mass density in UV faint galaxies. Correcting for these systematics results in a star formation history that agrees well with our inferences of the stellar mass density at z~2. I will briefly discuss the implications of this result for the evolution of the IMF and present constraints on the high mass end of the IMF from the UV spectra of z~2-3 galaxies.

Prof. Romeel Davé University of Arizona

## The Odd Meanderings of the IMF Across Cosmic Time

Our understanding of how galaxies form is far from complete, so it seems remarkable to suggest that one can constrain the IMF across cosmic time based on galaxy formation theory. Yet I will argue that this is now not only possible, but makes specific predictions for mild and non-monotonic variations in the typical IMF (more precisely, the IGIMF) of star-forming galaxies from z~0-6. The key observable used for such constraints is the specific star formation rate of galaxies as a function of redshift. Current models generically predict a different evolution that observed. One possible reconciliation is that the IMF in typical star-forming galaxies varies with cosmic epoch. Such IMF evolution can actually reconcile a wide range of disparate observations, including the late evolution of cluster ellipticals, the cosmic extragalactic background light, the number of carbon-enhanced metal poor stars in the Galaxy, and others. While there is no smoking gun evidence for IMF variations and each data set individually can be plausibly explained by systematic effects, the fact that a single evolving IMF broadly explains them all makes such a scenario worth consideration.

| Dr. | Eric | Murphy | Caltech/SSC |
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## The Possibility of Identifying Variations to the IMF at High-z Through Deep Radio Surveys

While star-forming galaxies are currently thought to be responsible for completely reionizing the intergalactic medium (IGM) by z~6 (e.g., Becker et al. 2001; Fan et al. 2006), the ionizing flux arising from star formation in Lyman break galaxies at similar redshifts (Bouwens et al. 2007, 2008) appears to fall a factor of >~6 below the minimum value required to maintain an ionized IGM for a given clumping factor and escape fraction under the assumption of a Salpeter stellar initial mass function (IMF). Chary (2008) has shown that this discrepancy can be reconciled by flattening the stellar IMF to have a slope of ~ -1.7 if reionization occurred at z = 9 thus increasing the ionizing photon rate. While the idea of a top heavy IMF at these epochs does not seem completely inappropriate given that low metallicity environments will favor the production of more high-mass stars, trying to identify such a variation remains difficult. At such high redshifts, I will argue that deep radio continuum observations at frequencies >10 GHz using next generation facilities like the SKA will likely provide the most accurate measurements for the ionizing photon rates (star formation rates) of normal galaxies sin the non-thermal emission from such galaxies should be completely suppressed due to the increased inverse Compton (IC) scattering off of the cosmic microwave background (CMB), leaving only the thermal (free-free) emission detectable. Thus, a careful analysis of such observations in combination with future JWST measurements of the rest-frame UV emission from the same population of galaxies may yield the best means to search for variability in the stellar IMF at such epochs.

# Poster Abstracts
**(alphabetical)**

Dr. Jennifer Donovan Meyer Physics and Astronomy Dept. SUNY Stony Brook Poster

## Star Formation in the Outskirts of Early Type Galaxies

GALEX has enabled the discovery that extended star formation is not uncommon in the outskirts of spiral galaxies. It has also enabled the discovery of low levels of star formation in the outskirts of some early type galaxies, often coincident with the detection of HI (when such observations are available). These regions often lack corresponding detections in H-alpha emission, raising questions about the IMF at work at large galactic radii. I will present a study of the stellar populations in the outskirts of a sample of early types in the context of the IMF discussion.

| Mr. | Michele | Fumagalli | UC Santa Cruz | Poster |
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## SLUG: A new way to Stochastically Light Up Galaxies

Stochastic star formation may offer an alternative explanation for evidence of a varying initial mass function (IMF). Incomplete sampling of the IMF in regions with low rates of star formation tends to produce populations that are deficient in high mass stars even if the underlying stellar IMF is independent of the star formation rate. This stochastic effect, combined with stellar evolution and cluster disruption, may explain the high UV to Ha ratio observed in dwarf galaxies and in the outskirts of some spirals without resorting to changes in the IMF. We present SLUG, a new code to Stochastically Light Up Galaxies as a test for the evidence of IMF variations. SLUG populates star clusters by drawing stars from canonical IMFs. It then follows the time evolution of the clusters using standard stellar evolution tracks and an observationally-motivated model for cluster disruption. For a choice of star formation rate and IMF, SLUG outputs predictions of the distribution of cluster UV, Ha, and bolometric luminosities with a proper treatment of stochastic star formation. Future versions will support a range of metallicities and non-constant star formation histories as well. Using SLUG, we are able to generate a realistic distribution of star clusters, demonstrating the range of properties that result from finite sampling and a random distribution of ages. This synthetic data set provides a crucial control against which claims to detect IMF variation must be tested. This code will be made publicly available. (SLUG is developed by Robert da Silva, Michele Fumagalli, Mark Krumholz and Frank Bigiel)

| Prof. | Mauro | Giavalisco | University of Massachusetts | Poster |
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## Star Formation in Massive Galaxies at Redshift 2<4

We present evidence of different modes of star formation in massive (10^10-10^11 M_sun) galaxies at redshift 2<4. While current samples still suffer from limited sensitivity in comparison to the local universe, we show that the latest instrumentation has significantly increased the range of spectral types accessible to observations at these early epochs. We review the properties of galaxies of various spectral types and discuss the implications for galaxy evolution in general, focusing in particular on the possible mechanisms more likely to drive the evolution.

| Ms. | Wen-hsin | Hsu | Univerisity of Michigan | Poster |
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## Competitive Accretion in Sheet Geometry and the Stellar IMF

We report a set of numerical experiments aimed at addressing the applicability of competitive accretion to explain the high-mass end of the stellar initial mass function in initially non-clustered environments, in contrast to most previous simulations which have assumed formation in a cluster gravitational potential. We adopted a simple cloud model with a sheet or flat geometry, motivated by models of molecular cloud formation due to large-scale flows in the interstellar medium. The experiments consisted of SPH simulations of gas accretion onto sink particles formed rapidly from Jeans-unstable dense clumps placed randomly in the finite as sheet. These simplifications allow us to study accretion with a minimum of free parameters, and to develop better statistics on the resulting mass spectra. We considered both clumps of equal mass and Gaussian distributions of masses, and either uniform or spatially-varying gas densities. In all cases, the sink mass function develops a power law tail at high masses, with dN/dlogM ∝ M^{-Gamma}. The accretion rates of individual sinks follow Mdot ∝ M^2 at high masses; this results in a continual flattening of the slope of the mass function towards an asymptotic form Gamma ~1 (where the Salpeter slope is Gamma = 1.35). The asymptotic limit is most rapidly reached when starting from a relatively broad distribution of initial sink masses. In general the resulting upper mass slope is correlated with the maximum sink mass; higher sink masses are found in simulations with flatter upper mass slopes. Although these simulations are of a highly idealized situation, the results suggest that competitive accretion may be relevant in a wider variety of environments than previously considered, and in particular that the upper mass distribution may generally evolve towards a limiting value of Gamma ~1.

Poster

| Ms. | Hwihyun | Kim | Arizona State University | Poster |
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## Study of Resolved Stellar Populations in M83 using HST/WFC3 Early Release Science Data

We present a multi-wavelength photometric study of individual stars in M83 based on observations taken as part of the WFC3 Early Release Science (ERS) program. The central region of M83 has been imaged in seven broad-band filters to obtain multi-wavelength coverage from the ultra-violet to near-infrared. We use four filters--F336W, F438W, F555W, and F814W--to measure the effective temperature and intrinsic luminosity for ~10,000 stars. These measurements are used to determine the recent (< 1 Gyr) star formation history of M83. We selected 30 regions in the spiral arm and the inter-arm area of M83 and categorize them based on their Hα morphology. To determine ages of stars in each region, we use color-magnitude diagrams (CMD) and color-color diagrams with the Padova Isochrones for a metallicity of Z=0.03 (1.5 Z_sun), and compare to ages determined by cluster age-estimates from Hα morphology and from SED fitting. The CMD and color-color diagrams of resolved stars from the multi-band HST/WFC3 observations of M83 indicate the presence of multiple stellar populations: the recently formed main-sequence, He-burning blue-loop, red giant branch, and asymptotic giant branch stars. Multi-populations of stars in the CMDs of the 30 selected regions indicate that stars in a single region may not have formed from the same star formation event. Also, we find that the regions with ages determined younger than 10 Myr are located preferentially along the active star-forming region on the spiral arm.

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| Dr. | Jan | Pflamm-Altenberg | AIfA Bonn | Poster |
| Dr. | Gerhard | Hensler | Institute of Astronomy, University of Vienna | |


## Accretion-regulated star formation in galaxies

Star formation in galaxies is understood to be a self-regulated process and the SFR is physically determined by the gas mass or density (Kennicutt-Schmidt law). We show that in the case of gas accretion the SFR of a galaxy is entirely coupled to the gas accretion rate and the self-regulated star formation mode is replaced by an accretion-regulated one. This has implications for revised star formation rates of galaxies.

| Dr. | Andrea | Urban | JPL/Caltech | Poster |
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## Studying the effect of radiation and dust-gas energetics on clustered star formation

Using simulations of a cluster-scale environment we investigate the effect of heating and cooling on the formation of a young cluster and its mass function. Our dust-gas energetics algorithm includes a simplified radiative transfer method, dust-gas collisional heating, molecular cooling, and cosmic-ray ionization. In our simulation, we find that the newly-formed stars, by heating the dust and gas in the cluster, influence the formation of future stars. The luminosity from the massive stars affects the mass function, dust/gas temperature, star formation efficiency, and maximum stellar mass in the cluster.

| Dr. | Linda | Watson | Ohio State University | Poster |
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## Testing the Star Formation Law in Bulgeless Disk Galaxies

We study the relation between gas and star formation surface density in twenty bulgeless disk galaxies using data from the VLA, IRAM 30m, MDM, Spitzer IRAC, and HST. Recent work has provided constraints on the physics that sets the star formation efficiency (SFE) in varying environments of the interstellar medium; however, a single theory for star formation has yet to stand out among its peers. The general motivation for our work is to test the predictive power of current theories with substantially improved observations of late-type and low-mass disks, which are underrepresented in most surveys. We specifically study star formation and the properties of the cold ISM above and below the circular velocity threshold of 120 km/s (stellar mass ~ 10^10 M_sun), where Dalcanton et al. (2004) found that edge-on disk galaxies show an abrupt transition in their dust scale heights. This transition also corresponds to a disk stability transition according to the Toomre Q parameter. We will present our study of a sample of nearby, moderately inclined galaxies that bracket this transition velocity, focusing on their location relative to the star formation law, an analysis of the effect of disk stability on SFE, and implications for a general theory of star formation.

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| Dr. | Aida | Wofford | Space Telescope Science Institute | Poster |

## The Massive Star Initial Mass Function of Circumnuclear Clusters in M83

The circumnuclear starburst of M83 (NGC 5236), the nearest such example, is an ideal site for studying the massive star initial mass function (IMF) at high metallicity. We analyze archival Hubble Space Telescope (HST) observations, including ultraviolet imaging and spectroscopy, of compact star clusters located within M83's starburst. We compare the observed spectra with two sets of Starburst99 models, older, semi-empirical models (Robert et al. 1993) and new fully theoretical models based on a new synthetic library of high-resolution UV spectra for hot massive stars (Leitherer et al. 2010). We generate single stellar population models with metallicities of Z=0.020 and Z=0.040, using different high mass limits and slopes for the upper IMF, and determine the intrinsic reddenings, masses, and ages of the brightest clusters in M83's starburst, based on the model that best fits the data.

Poster

| Dr. | Ted | Wyder | Caltech | Poster |
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## H-alpha and UV imaging of XUV disks and LSB galaxies

GALEX observations have revealed UV emission extending far beyond the optical and H-alpha discs of several nearby spiral galaxies, raising the question of possible massive star deficiency, i.e. deviations from the standard 'universal' IMF at the upper end, in certain low density environments. We have undertaken an H-alpha survey of low surface brightness galaxies observed by GALEX and with existing HI maps with the aim of investigating the variation of the H-alpha/UV ratio with the local density. Here we present preliminary results for 14 such galaxies observed with the Large Format Camera on the Palomar 200in telescope using custom narrow band filters.

Mr. Harus Zahid Institute for Astronomy UH Manoa Poster

## The MZ and LZ relation from DEEP2 at z ~ 0.8

We present results from a study investigating the evolution of the mass-metallicity and luminosity-metallicity relation over cosmological timescales. We determine the metallicities from strong-line diagnostics for 940 emission line galaxies from the Deep Extragalactic Evolutionary Probe 2 (DEEP2) redshift survey in the redshift range of 0.75<0.82. We determine masses by fitting the SED inferred from photometry with stellar population synthesis models. We compare our determination of the MZ and LZ relation with the local relation from SDSS. We show that at z~0.8 galaxies with masses M~10^10.5 M_solar have already achieved the level of enrichment observed in the local universe. The mass-metallicity relation for z ~ 0.8 has slightly steeper slope than the local relation and the mean difference in metallicity is ~0.05 dex. We examine the luminosity-metallicity relation and determine that the slope of the relation at z~0.8 is consistent with the local relation. The metallicity at a given luminosity in the z~0.8 is offset from the local relation by ~0.12 dex. We attribute the discrepancy between the metallicity evolution inferred from the mass-metallicity and luminosity-metallicity relation to luminosity evolution in the population of blue star-forming galaxies. We infer a B-band luminosity evolution of ~0.8 mags for the population of star-forming galaxies. We estimate gas masses from the Schmidt-Kennicutt star formation law and determine the effective yields for our sample. We observe an effective yield that decreases with increasing stellar mass and take this as evidence for the inconsequential role of galactic flows in shaping the mass-metallicity relation. We propose that the evolution of the mass-metallicity relation is a consequence of relative increase in the mass of metals with respect to the mass of gas, though both are observed to decrease. One possible explanation for such an evolution is a varying IMF.

| Dr. | Hongxin | Zhang | Lowell Observatory | Poster |
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## Population Analysis of the LITTLE THINGS Sample

We have assembled a multi-wavelength dataset, including deep interferometric HI maps, on a sample of 41 relatively normal, nearby gas-rich dwarf (dIm) galaxies (LITTLE THINGS). These data trace stellar populations, gas content, and dynamics for the purpose of testing and modifying star formation models. Here we present the results of stellar population analysis for the whole sample using multi-wavelength broadband data from GALEX FUV to IRAC 3.6um. Considering the extreme properties (e.g. low metallicity, low gas surface density) of these dwarf galaxies, we experiment with various possible characteristics, such as a steep IMF, a steep extinction law, and extreme star formation histories on this sample. Based on our population modeling, we try to discuss the global star formation histories for the dwarf irregular galaxies in general.

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