# A WISE(R) View of Old Stellar Populations Mark A. Norris ApJ accepted / astro-ph/1407.6005

1 AP



# Lorentz, center

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• Measuring stellar mass is conceptually simple...







# Stellar Mass

SFH

Measuring stellar mass is conceptually simple... but in practice difficult

# Ongoing star formation

AGN

### **Dust: Emission** and Absorption



### **Rare stellar phases** - e.g. TP-AGB

**IMF Variation** 

Non-stellar emission

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  - Reduced sensitivity to SFH (Meidt+14)











Barmby+12



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### • Large (1.56 x 1.56 deg) FoV good background removal.





# Why WISE?

W1 / 3.4 μm W2 / 4.6 μm W3 / 12.0 μm







- Examined all MW, LMC, SMC, and M31 GCs brighter than  $M_v < -7$ .
- Also included any literature ETGs with necessary information.
- Used very simple/robust analysis procedure.













Bruzual&Charlot03, Marigo+08, Conroy+09, Kotulla+09, Bressan+12, Meidt+14







For Kroupa IMF



Bruzual&Charlot03, Marigo+08, Conroy+09, Kotulla+09, Bressan+12, Meidt+14









#### SAURON galaxies with Luminosity Weighted Ages

(from Kuntschner +12)



Stella

AS<sup>3</sup>D

ATL





SAURON galaxies with Luminosity Weighted Ages (from Kuntschner +12)

ATLAS<sup>3</sup>D galaxies with Mass Weighted Ages (from McDermid +14)









ATLAS<sup>3</sup>D galaxies with Mass Weighted Ages (from McDermid +14)







Cappellari+12

# A Strong of Astronomy Astr











ATLAS<sup>3</sup>D galaxies with Mass Weighted Ages (from McDermid +14)











# Conclusions

- Measured W1, W2 photometry of a large sample of old stellar populations.
- Found a subset of models that reproduce W1, W2 photometry.
- Determined M/L ratios for W1 and W2.
- Found that simple luminosity-weighted ages + IRAC1/W1/IRAC2/W2 luminosity enough to determine accurate stellar mass.
- Confirmed IMF variation in ETGs.









[H/Z]Atlas<sup>3D</sup> |





















- Mass is the most fundamental property of galaxies - controlling many others:
  - Star formation rate (e.g. Li+11)
  - Assembly history (e.g. Kauffmann+03)
  - Colour (e.g. Peng+10)
  - Morphology (e.g. Bamford+09)

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• Determining the different mass components (dark matter, stellar +remnant, gas, and dust) in galaxies is essential to understand the galaxy formation process.

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#### Dark Matter

EAGLE simulations Y OF GALAXIES AND THEIR ENVIRONMENTS

z = 0.0= 0.4 cMpc

Visible components CDM

#### **EAGLE Simulations - Rob Crain**





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#### Gas



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#### Stellar Mass + Remnants



#### **EAGLE Simulations - Rob Crain**





 Several lines of evidence now seem to show that the IMF does vary in early type galaxies.



### Astronomie Leide Der Lorentz Astronomiume As

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### Outliers

- NGC2549: Edge on disk
- NGC3156: Edge on disk bright starburst in inner region detected gas
- NGC4150: Inclined disk dust lanes detected gas
- NGC4550: Edge-on disk
- NGC7457: Inclined disk

