Challenges in galactic astronomy in the ‘40

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Brainstorming! Trying to be representative of a community…

Horizon: next large ESO facility after ELT

An effort worth trying but … hard to tell the future

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What I think we will want to know from a resolved stellar population perspective?

Formation and evolution of galaxies / galactic archeology – challenging/confirming the standard model [motions / ages / chemical composition]

Formation and evolution of star clusters [motions / ages / chemical composition]

Star formation histories [ages / chemical composition]

Role of dwarf galaxies (and clusters) in the evolution of the Universe [SEDs / ages / chemical comp.]

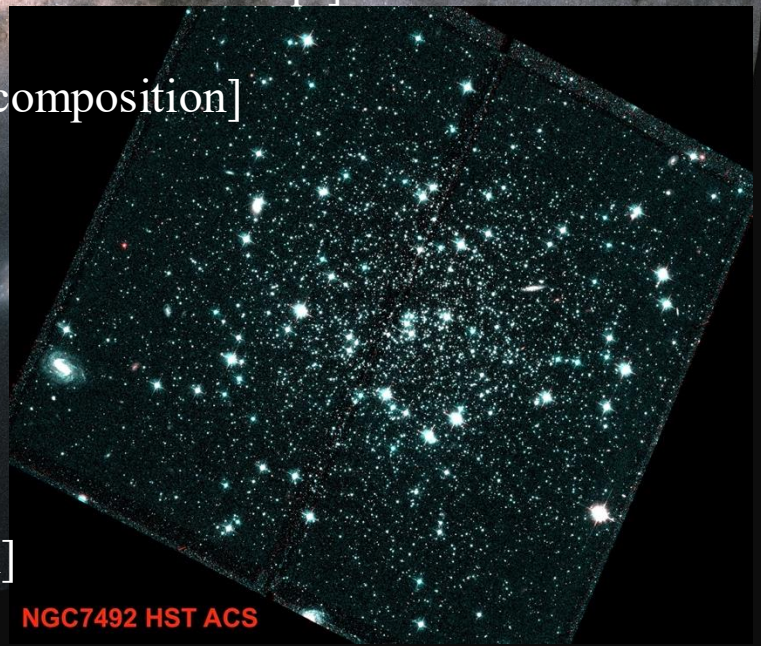
Life of baryons / nucleosyntheis / chemical evolution of galaxies [ages / chemical composition]

The dark sector from the kynematics of stars [motions]

Stellar mass & intermediate-mass black holes [motions]

Stellar standard candles and the distance scale [parallaxes / chemical composition]

Variable stars / the transient Universe [time series / motions / chemical composition]



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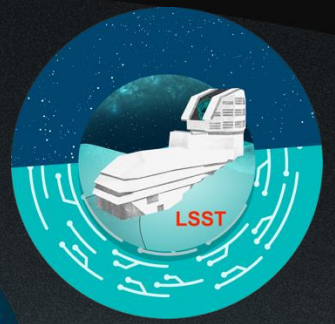
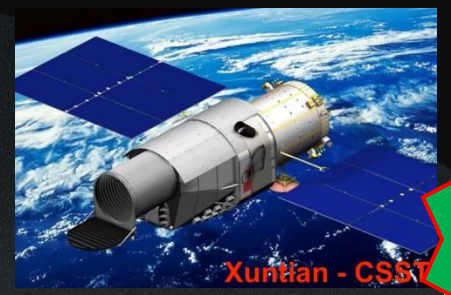
A complete census of the Local Universe (faint LF vs ΛCDM)
Finding out all the galaxies and star clusters in the LG:
Deep wide-field imaging and photometry

Galactic dynamics and archeology
Absolute proper motions over the Galaxy and its immediate surroundings; geometric distances to as many stars and standard candles as possible:
All-sky astrometry + photometry





Not suitable for ESO '40

What we miss:
A northern version of LSST
An all-sky imaging survey from space in the optical-NIR

GaiaNIR

What we miss:
An effective successor of Gaia really able to cope with crowding to go much deeper in the densest regions of the MW and to pierce th veil of dust

Not suitable for ESO '40

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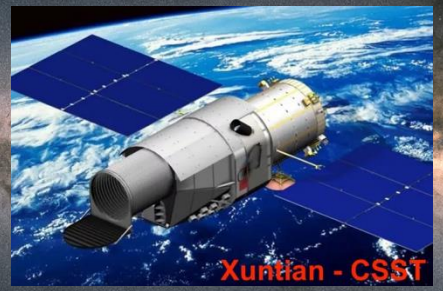
Resolving distant galaxies into stars, extremely dense/crowded environments
High precision kinematics of systems on small scales
High spatial resolution: photometry, spectroscopy and astrometry



What we miss:
A further step ahead.
Efficient AO in the optical?
Interferometry?

Core business of the current upcoming ESO facility
+
Future ELT instrumentation
+ space facilities

Tracing HI distribution and kinematics also very helpful for many goals in this and in the previous slide: FAST, Chords, SKA – we should be reasonably safe on this side

We can co ahead in the exercise of going through my list of wishes:

Variable stars – transient Universe ➔ LSST

Intermediate-mass black holes ➔ ELT

We can do it after my main conclusion if you like…

A classic holy grail for resolved stellar populations is: **AGE**

…but, unfortunately, we cannot build an age-meter. We need magnitudes, distances and chemical compositions to be obtained with different instruments/facilities to be combined together

Or we need asteroseismology (to measure stellar mass) but this is not easy for faint/distant stars and it is done better from space.

It does not seem an appropriate driver for this specific project at this stage

So my main conclusion is that we need spectra to be acquired over a wide field and/or with integral field at an industrial pace

- To match Gaia and Gaia-NIR catalogues with RV and chemical composition
- To follow-up discoveries from imaging surveys and future imaging facilities
- To patrol the Galaxy and the Local Group down to much fainter magnitudes wrt, e.g, WEAVE and 4most
- To sample velocity fields in stellar systems on scales from arcmin to degrees: the most interesting range for tracing dark matter
- To go in full survey mode, allowing new discoveries
- To have a very flexible, multi-purpose facility

The actual set-up by which which we get industrial scale **wide-field and/or integral field spectroscopy** is not critical: large FoV, high multiplexing, integral field capabilities, spectral resolution are critical

A spectral resolution of about 6-8000 would be enough to achieve many of the main goals but, obviously, high resolution opens extremely valuable windows. Vision and perspective call for both. **However, a system working at low-res with higher efficiency + advanced machine learning+AI may be highly competitive in the '40s**

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What can drive radically different choices:

- The emergency of a fundamental scientific issue or a drastical change in priorities requiring a specific experiment / instrumental set up

- A breakthrough technologic advancement enabling science that is currently out of reach or unthinkable

me staring at the '40…
(on the right in the picture)

Thank you!