ADeLA 2016 @ Bogotá

- GAIA DR1
- Astrometry with and after GAIA
    o Ground-based
    o Space-based
- Galactic astrophysics
- Stellar astrophysics
- Geodesy and space debris
- Statistical tools
- Education
- History of astrometry

GAIA DR1

GAIA DR1 (Martin, Claus, Sebastien, Erick)
- Tycho-2 + GAIA DR1: TGAS now available to community
- Special 135K QSOs solution mostly in the northern hemisphere with a very slight bias in PM with respect to ICRF2
- Larger than expected +/-1 mas fluctuations of basic angle (offset of parallax point, already corrected, cause still not fully understood)
- Scattered stray light (brighter limiting magnitude)
- What is not there:
    - High pm, very red or blue or fast objects, variable and binaries
- What is there:
    - 60-100 micro-arcsec/yr precision in proper motions
    - 30 micro-arcsec/yr accuracy in proper motions
    - Parallax uncertainties already below 1 mas
    - 2M objects to play and do science!
- Ground tracking of GAIA critical to its astrometric performance

- Orbit calculation of GAIA satellite is an input parameter for the astrometric solution
- Orbit velocity errors introduce aberration effects
- Satellite ended up being 3 mags fainter than estimated (21 mag)
- The Pleiades scandal: TGAS confirms traditional 135 pc distance, therefore rejecting Hipparcos 120 pc value (spin-synchronous errors)
- Most important Hipparcos contribution = parallaxes (Erick)
- GAIA is not killing ground-based astronomy (Martin)
- Possible 2-5 yr extension

Astrometry with and after GAIA: Space-based

The next project in space astrometry:
- 2nd but now infrared GAIA in 20 yrs
- Two is better than one
- Soon to be formally proposed to ESA

Astrometry with and after GAIA: Ground-based

URAT: automated survey, successor of UCAC
- time-domain astronomy
- quick tracking
- > UPC = current largest ground-based parallax catalogue
- supplement GAIA in the bright end
- open to collaborations

Astrometry with large CCD mosaic cameras (e.g. LSST, VISTA)
- A trend in astronomy: larger, deeper and faster surveys
- LSST
- images 3.5 deg across field of view

- down to 24 mag in r
- whole visible sky in 3 nights
- Science goals: weak/strong lensing implications in dark matter & energy, transient variable universe, resolve stars in nearby galaxies, solar system inventory
- Deeper than GAIA, PM errors from 0.1 to 1 mas/yr, parallax errors from 0.5 to 3 mas
- Will extend GAIA's faint end limit
- Challenges:
  - Electronics and read-out related systematics
  - They affect galaxies vs stars differently
- All upcoming future surveys should include precise detailed astrometric reductions and programs as a key ingredient to produce valuable science
- VISTA
  - VISTA Variables in the Via Lactea (VVV)
  - Galaxy in the infrared is completely different thing!
  - Census of solar neighbourhood for all red faint low mass things
  - High PM objects
  - Go all the way to the far disk of the Milky Way!!!! … aaahhhh!!!!
  - Data mining techniques

Improved reduction of ground based non-astrometric and astrometric catalogs (Ivan, 2MASS)

Subjects outside GAIA scope:
- Slow moving objects:
  - GAIA is looking during a rather short timescale (<10 yrs)
- Objects fainter than 20-21 mag can have better astrometric data from ground based astrometry

Galactic astrophysics

VPOS: Vast Polar Structure
- Are galaxies contained and moving within it or we just catch them in a chance alignment?
- A few other instances seen (Andromeda)
- Accretion of a group of dwarf galaxies or collision with a "ghost" small galaxy can produce it, still number of "truly aligned galaxies" is about half of what is seen.
- PM are the key to disentangle and solve this issue (Dana)

Sagittarius stellar streams
- It is somewhat easy to get the streams in simulations
- It is harder to reproduce in the simulations all other observables (M/L, velocity dispersion, age-lifetime)
- Again, PM can make the difference

Spiral arms structure using open clusters

Recent star formation outside the LMC

Stellar astrophysics

Brown dwarf formation scenarios
- PM dispersion can help to validate/reject those that predict specific velocity dispersions
- Using VISTA science verification data only!

Trapezia
- Disintegrate quicker than thought before
- Escapees have generally low mass and low velocity

- Source of open (wide) binaries

Wide or open binaries:
- PM are a very good detector of true wide binaries (success rate 55%)
- So few yet that one can make a difference
- Constrain dark matter content
- Using VISTA/USNO-B, SPM4

Speckle imaging:
- Very high resolution imaging down to telescope diffraction limit
- Two is better than one
- Binarity fraction in K stars
- Exoplanets with multiple stars (about half)
- Secondaries in wide binaries

Geodesy and space debris

Updates on astrometry applied to geodesy from San Juan, Argentina (Ana Maria, Ricardo)
- 10 yrs of SLR
- GPS station for IERS
- DORIS beacon
- 40m radio telescope (CART) 1-45 GHz, early 2018
- Becoming a fundamental reference point for linking celestial and terrestrial reference frame (ITRF, ICRF)

Space satellites and debris (Elvis, Rodolfo)
- Humans are littering the GEO ring
- Astrometry provides 20-m error orientation coordinates, i.e. angular positions on the sky, vs. telemetry's few kilometres

- ISON numbers
  - 37 observatories
  - 80 telescopes
  - 15 countries
  - > 300 new objects founds
  - aprox 300 lost objects found
  - all invited to join this network

Nanosatellites : lifetime in LEO

Statistical tools

Cramer-Rao limit:
- Multidisciplinary work: mathematics and information theory applied to compute lower bounds to the uncertainty of an estimator
- Parametric setting: It tells you the best you can do, but how you get there is YOUR problem
- Bayesian setting: use prior information, you can do even better and it gives you the best estimator!
- Bayesian is THE TREND now in astronomy and astrometry does not escape this

Bayesian, Genetic and optimization algorithms
- Finding invisible exoplanets
- Lower bounds of photometric errors
- Andromeda satellites dynamics using Non-Linear Programming optimization techniques

Education

- GAIA is providing us with
  - o Exquisite data at our desktops

- No need to apply/get access to large telescopes
- Opportunity to compete for all so go and prepare

- Astrometry for Astrophysics ed. Bill van Altena is the book you need to know what and how to do in astrometry today

History of astrometry

Told by one of his most important main characters

Some other important things we learnt:

- Tycho is pronounced TEE-KOH (blame Wikipedia for the wrong phonetics)
- TGAS is pronounced TEE-GAS
- Y en español: Escandir en vez de "scan"

Final comments about ADeLA

- Thanks to LOC and SOC
- Thanks to RMxAA that publishes our proceedings
- Thanks to all attendees especially those from outside LA
- ADeLA as the conference for astrometry in this side of the world
  - 15 yrs: Small but resilient community
  - Spanish/Portuguese/English speaking participants are all welcome, becoming with time more and more international beyond LA
- Astrometry today and in the future is in Europe, LA and Asia (Bill)