ELT: Stars+Planets Summary

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IAC *AIP*

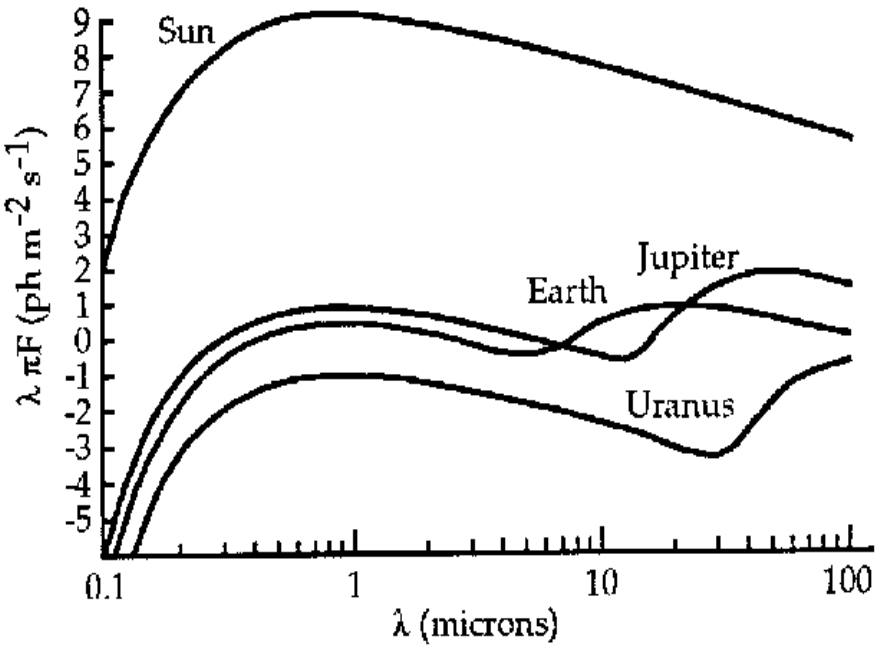
Outline

- Exoplanets
  - Terrestrial planets in habitable zones “Exo-earths”
  - Giant planets: evolution and characterisation
  - Planetary systems
- Our Solar System
  - Mapping planets, moons and asteroids
  - Transneptunian objects
  - Comets and the Oort cloud
- Stars and disks
  - Formation of stars and protoplanetary disks
  - The lives of stars
  - Compact objects: neutron stars and black holes in the Galaxy
  -- Microlenses

Requirements

- FoV
- Spatial resolution
- Spectral resolution
- Lambda
- Observations
- Target density
- Special requirements
- Dynamic range constraint
- Comparison of 30m, 50m, 100m
- Observing time needed
- Time frame constraint

Exoplanets



- Terrestrial planets in habitable zones "Exo-earths"
  - Challenges
    - Adaptive Optics
    - Planetary imaging
      - suppresion of star light by a factor >10^9
      - noise treatment
        speckle, star photon noise, etc.

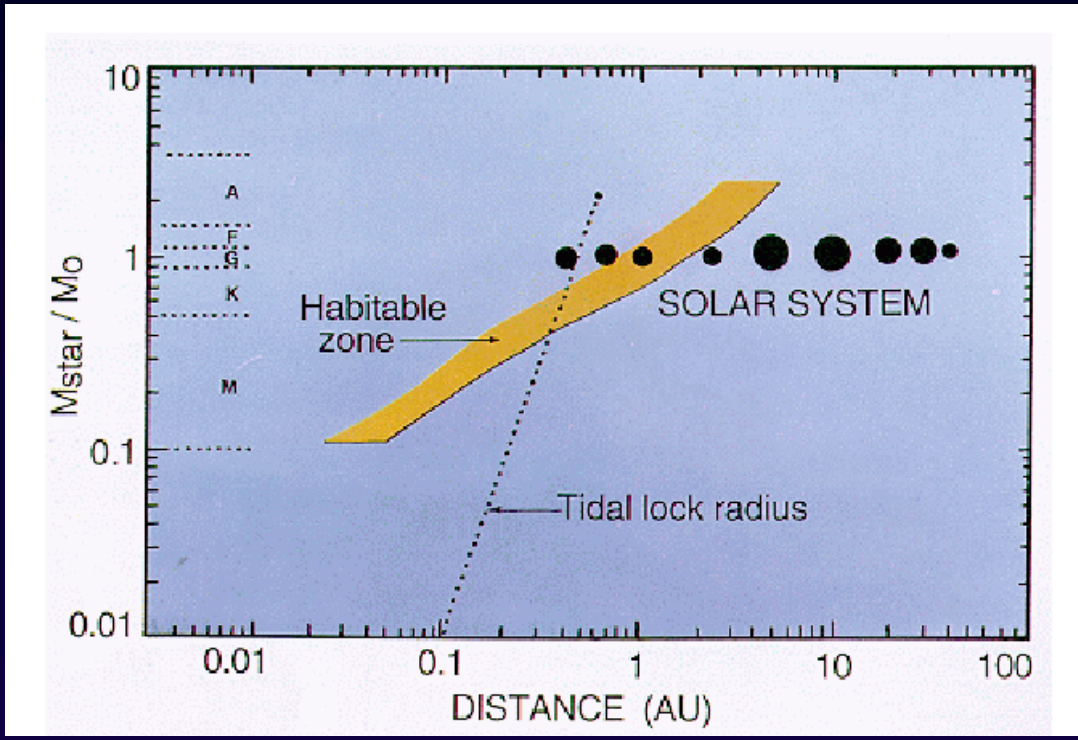
Diffraction limited resolution

Hainaut & Gilmozz

Band	B	V	R	I	J	H	K	N	
Resolution λ/D (100m)	0.9	1.1	1.3		2.6	3.4	4.5	23	mArcsec
(50 m)	1.8	2.2	2.4		5.2	6.8	9.0	46	“”

Exoplanets

- Terrestrial planets in habitable zones "Exo-earths"



  - Goals: Detecting "exo-earths" around solar type stars up to 50 pc (1 AU → 20 mas)
    - Spectroscopic characterization of biomarkers: optical and near IR
      - Molecular oxygen bands "B" absorption complex at 760 nm
      - Clorophyle cut off at 725 nm
      - Water vapour bands

Exoplanets

- Terrestrial planets in habitable zones “Exo-earths”

Preliminary Requirements:

Extreme AO @ 700 nm
Suppresion of star light :coronography/ differential imaging, other?

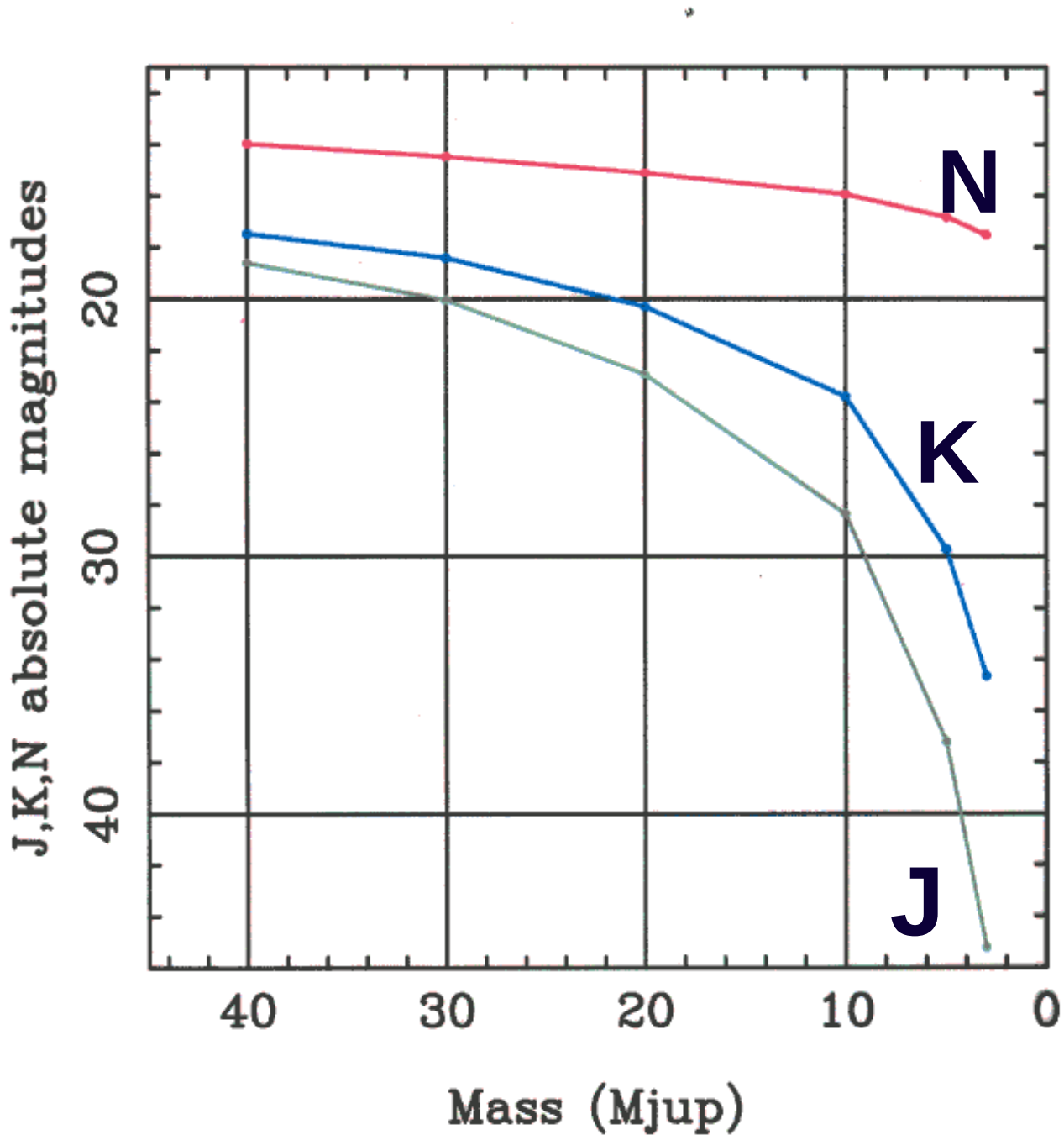
Photometry I-band
Spectroscopy 700-2200 nm (R>20)
FoV < 2 arcsec

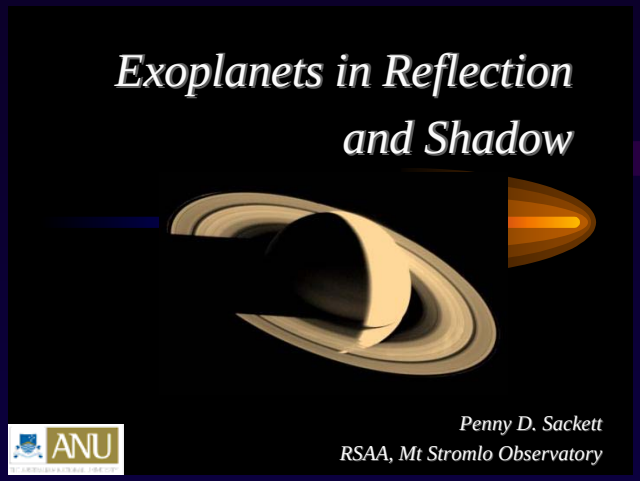
Action:
establish a working group that provides
consistent modelling of PSF, AO, speckle and other error noise budget, etc.
Gilmozzi, Gratton , Chelli and others

Exoplanets

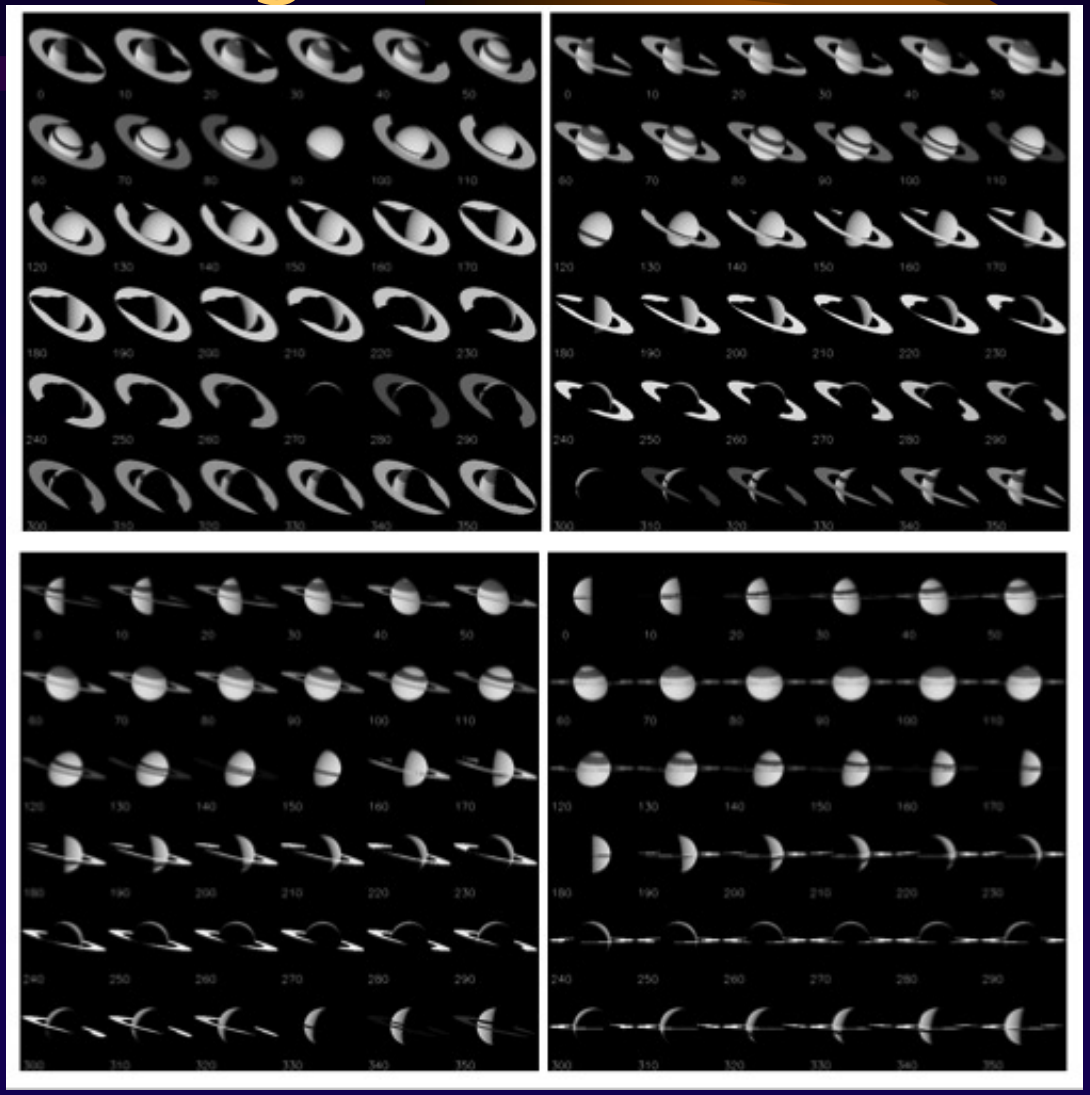
- Giant planets: evolution, characterization and rings
  - Mature (non-self luminous) giant gas planets
    - Warm Jupiters @ 1 AU of solar type stars out to 50 pc
  - Earth-like moons in the habitable zone:
    - Reflex velocity curve amplitude of 60 m/s, P~ days
    - Detection of transits
    - Methane spectroscopy
  - Young giant planets (nearby stars)
    - Brighter than old planets by several orders of magnitude
  - Free-floating planets in star clusters (in the field?)
    - Binary planets

New requirement: optical or near IR spectroscopy (R~10000)
mid IR spectroscopy


J,K,N absolute magnitudes
20
30
40
40
30
20
10
0
Mass (Mjup)
N
K
J



Ring size



Arnold & Schneider 2004,

A&A, 420, 1153

Our Solar System

- Mapping planets, moons and asteroids
  - Large and nearby asteroids
    - Complete surface maps showing topography and geological indicators at surface resolution of a few km
  - Small asteroids
    - Resolve main-belt objects with size down to ~10 km
  - Major and minor moons
    - Multiwavelength surface coverage of previously unstudied
  - Trans-neptunian objects
    - Does cometary activity occur
    - D/H ratios of the surface ices. Is the same in the Kuiper belt objects than in comets from the Oort cloud?
    - Was the terrestrial hydrosphere seeded from Oort of Kuiper belt objects?
    - Binary objects, masses and densities

Our Solar System

- Surface and atmospheric changes
  - Evolution of vulcanism in Io
  - Activation of the Centaurus
  - Surface activity in Triton
  - The collapse of the atmosphere of Pluto
    - Freezing in the 2000-2020 period

Stars and disks

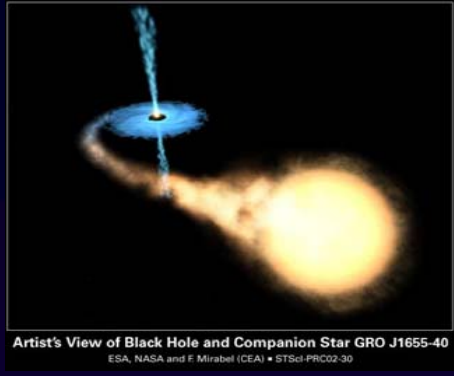
- Formation of stars and planetary systems
  - Birthplaces: fine structure, kinematics and chemistry of molecular clouds
  - Inner discs
    - The central 30 AU
      - Variations of molecular abundances with radial position
      - Gaps in discs
  - Embedded Young Stellar Objects
    - Class I-II
    - Origin of brown dwarfs
  - Outflow dynamics and moving shadows

Requirement: IFUs
High spectral resolution IR
Laser guide stars

Stars and disks

- The lives of stars
  - Early phases
    - Hot cores and compact HII regions
  - Mature phase:outflows
  - Normal and peculiar stars:
    - resolved stellar features
    - multiplicity
  - Asteroseismology
  - Chemical composition
    - Constraints on nucleosynthesis
    - nucleocosmochronology

Stars and disks



- The death of stars
  - Mass function of black holes and neutron stars
    - Optical/near IR identification of LMXBs everywhere in the Galaxy: about 100 will be identified during the lifetime of the ELT.
    - Dynamical masses of stellar black holes and neutron stars: constraints on equation of state

  - Isolated neutron stars
    - Fast photometry (30 ms periods)
    - high time resolution spectroscopy
  - Black holes in Globular Clusters
    - Dispersion velocities of stars in the cores
    - Optical Astrometry with a precision of 50 microarcsec
      - Stellar orbits around black holes
  - The Center of the Milky Way