Space Astronomy in the 90s

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Why Space Astronomy?

- SHARPER PICTURES (Spatial Resolution)

  The Earth's atmosphere messes up the light coming in (stars twinkle, etc).

- TECHNICOLOR (X-ray, infrared, etc)

  The atmosphere also absorbs light of different wavelengths (colors) outside the visible range. X-ray astronomy is impossible from the Earth's surface.

What are the differences between satellite instruments?

- Focussing optics or bare detectors
- Wavelength or energy range - IR, UV, etc. Different technology used for different wavebands.
- Spatial Resolution (how sharp a picture?)
- Spatial Field of View (how large a piece of sky?)
- Spectral Resolution (can it tell photons of different energies apart?)
- Spectral Field of View (bandwidth)
- Sensitivity
- Pointing Accuracy
- Lifetime
- Orbit (hence operating efficiency, background, etc.)
- Scan or Point

What are the differences between satellites?

- Spinning or 3-axis pointing (older satellites spun around a fixed axis, precession let them eventually see different parts of the sky)
- Fixed or movable solar arrays (fixed arrays mean the spacecraft has to point near the plane perpendicular to the solar-satellite vector)

- Low or high orbit (low orbit has higher radiation, atmospheric drag, and more Earth occultation; high orbit has slower precession and no refurbishment opportunity)
- Propulsion to raise orbit?
- Other consumables (proportional counter gas, attitude control gas, liquid helium coolant)

What are the differences in operation?

- PI mission vs. GO mission

  PI = Principal Investigator. One of the people responsible for building the satellite. Nowadays often referred to as IPIs (Instrument PIs).

  GO = Guest Observer. Someone who just want to use the satellite. (Confusingly. the GO is the PI on his or her own grant, which is different from being a PI on the mission).

  A 'PI mission' is one in which the PIs get all the observing time. A 'GO mission' is one in which the GOs get most of the time. The PIs are guaranteed some fraction of the time (and are GTOs, Guaranteed Time Observers) as a reward for the decades of work invested in building it.

  The first GO missions were IUE and Einstein. Nowadays all big missions are GO missions (ASCA, AXAF, HST) but some smaller ones (COBE, Alexis) are PI missions.

- Sky Survey vs. Observatory

  Some missions scan the whole sky, cataloging every source they can see. Other missions are pointed at specific targets which are already known to be there (because they were discovered in a sky survey).

Who launches astronomy satellites?

There are three main players:

- NASA, the US National Aeronautics and Space Administration
- ESA, the European Space Agency,
- ISAS, the Japanese Institute of Space and Astronautical Sciences.

  There are a number of other agencies which occasionally launch astronomy satellites:

- The US Air Force and the US Navy
- IKI (The Institute for Space Exploration of the Russian Academy of Sciences)
- The Indian Space Research Organization
- Individual European nations (Italy; Germany; Denmark; formerly, England and France)
- Argentina and Israel also have plans.

Solar physics in space

I won't cover this topic, nor will I touch on planetary astronomy.

HST Instruments

- HSP High Speed Photometer (removed 1993)
- WF/PC Wide Field/Planetary Camera (removed 1993)
- FOC Faint Object Camera
- FOS Faint Object Spectrograph
- GHRS Goddard High Resolution Spectrograph
- COSTAR Corrective Optics Space Telescope Axial Replacement (in 1993)
- WF/PC II Wide Field/Planetary Camera II (in 1993)
- STIS Space Telescope Imaging Spectrograph (due 1997)
- NIC Near Infrared Camera (due 1997)
- HACE Hubble Advanced Camera for Exploration (due 2000)

Results from Space Astronomy in the 1990s

- Microwave Background spectrum and anisotropy measured (COBE)
- Gamma Ray Quasars discovered (CGRO)
- Gamma Ray Burst theory disproved (CGRO)
- Distances to nearby stars measured (Hipparcos)
- Optical jets and conical flows in quasars imaged (HST)
- Superluminal galactic binary systems (Granat, CGRO)
- X-ray absorbing material in quasars studied (ROSAT, ASCA)
- Evidence for substructure and continuing formation in clusters of galaxies (ROSAT)
- EUV sources cataloged (ROSAT, EUVE)
- Discovery of supersoft X-ray stellar sources (ROSAT)
- X-ray spectra of Type I and II supernova remnants different (ASCA)
- Tentative detection of helium intergalactic medium (HST)
- Light echo in SN1987A imaged (HST)
- Detection of gamma rays from old radio pulsars (ROSAT, CGRO)
- High redshift galaxy morphology (HST)
- High redshift quasars detected in X-rays (ROSAT)

- Annihilation source near Galactic Center located (Granat)

The Space Observatories

Great Observatories			
HST	Hubble Space Telescope	1990	Optical/UV
CGRO	Compton Gamma Ray Observatory	1991	Gamma ray
AXAF	Advanced X-ray Astrophysics Facility	1998?	X-ray, Soft X-ray
SIRTF	Space Infrared Telescope Facility	2001?	IR

Pretty Good Observatories			
COBE	Cosmic Background Explorer	1989	Microwave, Submm
	Hipparcos	1989	Optical
ROSAT	Rontgensatellit	1990	Soft X-ray, EUV
EUVE	Extreme Ultraviolet Explorer	1992	EUV
ASCA	Asuka	1993	X-ray
SOHO	Solar Heliospheric Observatory	1995	Solar UV, X
XTE	X-ray Timing Explorer	1995	X-ray
ISO	The Infrared Space Observatory	1995	IR
VSOP	VLBI Space Observatory Project	1996	Radio
SRG	Spektr Rontgen-Gamma	1997?	X-ray
XMM	X-ray Mirror Mission	1999	X-ray
	Integral	2000?	Gamma ray

Smaller Missions			
STS-35	Astro 1/BBXRT	1990	UV, X-ray
P89-1B	Alexis	1993	X-ray/EUV

DXS	Diffuse X-ray Spectrometer	1993	X-ray
ORFEUS	Orbiting... Far/EUV Spectrometer	1993	UV, EUV
SPTN-201	Spartan 201	1993-95	Solar UV
AUOS-SM	Koronas	1994	Solar UV,X
STS-67	Astro 2	1995	UV
SFU/IRTS	IR Telescope In Space	1995	IR
IEH	International EUV Hitchhiker	1995	EUV
HETE	High Energy Transient Experiment	1995	X-ray
SAC-B	Argentine satellite	1995	X-ray
SWAS	Submillimeter Wave Astronomy Satellite	1995	Submm
TRACE	Transition Region and Coronal Explorer	1997	Solar UV
WIRE	Wide Field Infrared Explorer	1998	IR
FUSE	Far Ultraviolet Spectroscopic Explorer	1998	EUV
Still Going...			
VGR-2	Voyager 2	1977	UV
IUE	International Ultraviolet Explorer	1978	UV
1A	Granat	1989	Hard X-ray