1: The Accelerating Universe and Dark Energy
High Redshift Type Ia Supernovae
The Evidence from Type Ia Supernovae

Constraints on equation of state
Composition of the Cosmos

Today:
- Dark Matter: 23%
- Photons: 15%
- Atoms: 4.6%

13.7 BILLION YEARS AGO:
- Dark Matter: 63%
- Neutrinos: 10%
- Atoms: 12%

(Universe 380,000 years old)
2: The Distance Scale and the Value of $H_0$
Cepheid Variable Star in the Spiral Galaxy M100

HST WFPC2
$H_0 = 72 \pm 8 \text{ km/s/Mpc}$
3: The Evolution of Galaxies and the Cosmic Star Formation Rate
Star formation rate is dropping at times earlier than 1 billion years.
Cosmic Reionization
Cosmic Reionization
4: Extrasolar Planets
Planet Eclipsing Star HD 209458

Relative Brightness of Star

3 Hours

Time
HST detects additional sodium absorption due to light passing through planetary atmosphere as planet transits across star.

Wavelength (nm)

Additional absorption due to planetary atmosphere

Normal absorption spike depth from star

Sun-like star

Gas-giant planet orbits its sun in 3.5 Earth days (orbit not to scale)

More light absorbed by planetary atmosphere (transit brightness depth not to scale)

Brightness of star

Time

Duration of transit
Detection of Methane

Exoplanet HD 189733b

Absorption (percentage)

Wavelength (microns)

Methane
Detection of Starspot on TrES-1
5: Dark Matter
Dark matter ring in Cl 0024+17
3-D Distribution of Dark Matter
6: Stellar Populations in Nearby Galaxies
Color-magnitude diagram reveals two populations: one of 6-11 Gyr, and one of 10-13.5 Gyr.
7: Supermassive Black Holes in Centers of Galaxies
BH Mass scales with Galaxy Size.
Correlation Between Black Hole Mass and Velocity Dispersion
Penetration into Culture

THE NEW YORK TIMES EDITORIALS/LETTERS FRIDAY, MAY 3, 2002

The Hubble Achievement

It seems hard to believe that we have already grown used to seeing images from the Hubble Space Telescope in the dozen years since it was first launched. But the startling pictures released this week from a newly restored Hubble are a reminder that we had, in fact, begun to take for granted our ability to peer into deep space, an ability no generation of humans has ever possessed before. In a sense, these new images, produced with cameras and power sources that were added or rejuvenated during a space shuttle flight in March, feel something like learning to see all over again. They

the real wonder appears. Beyond the uniformity of the naked-eye universe, there is this other universe, the one Hubble discovers with astonishing clarity. This is a place full of discordant objects, of cataclysmic disturbances. Galaxies devour each other. Stars form in infernos of gas and dust and light. And they do so against the backdrop of a sky that is almost unimaginably deep.

For what the Hubble cameras show us, especially in their new incarnation, is time itself. The distance of the distant objects in these images is measured as much by their relative youth, by how

It has taught us to see the properties of a universe humans have been able, for most of their history, to probe only with their thoughts.

when you begin to realize what these forms are that with their thoughts.
Sheer Beauty
Crab Nebula M1
To be continued...