The Evolving Violent Universe

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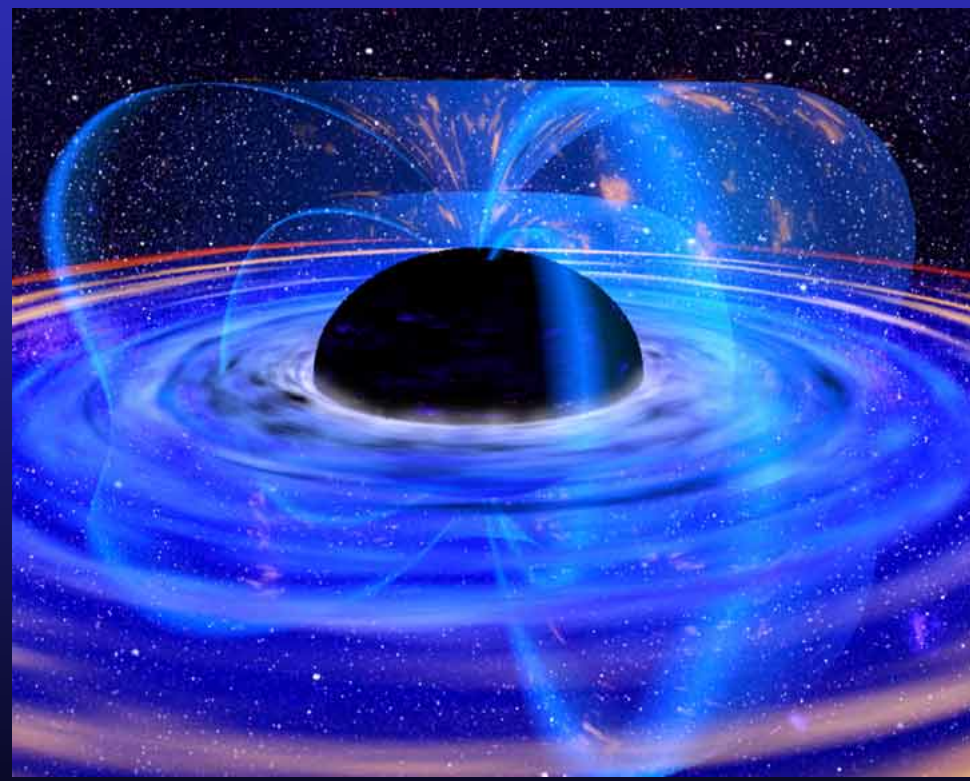
On behalf of ESA's AWG

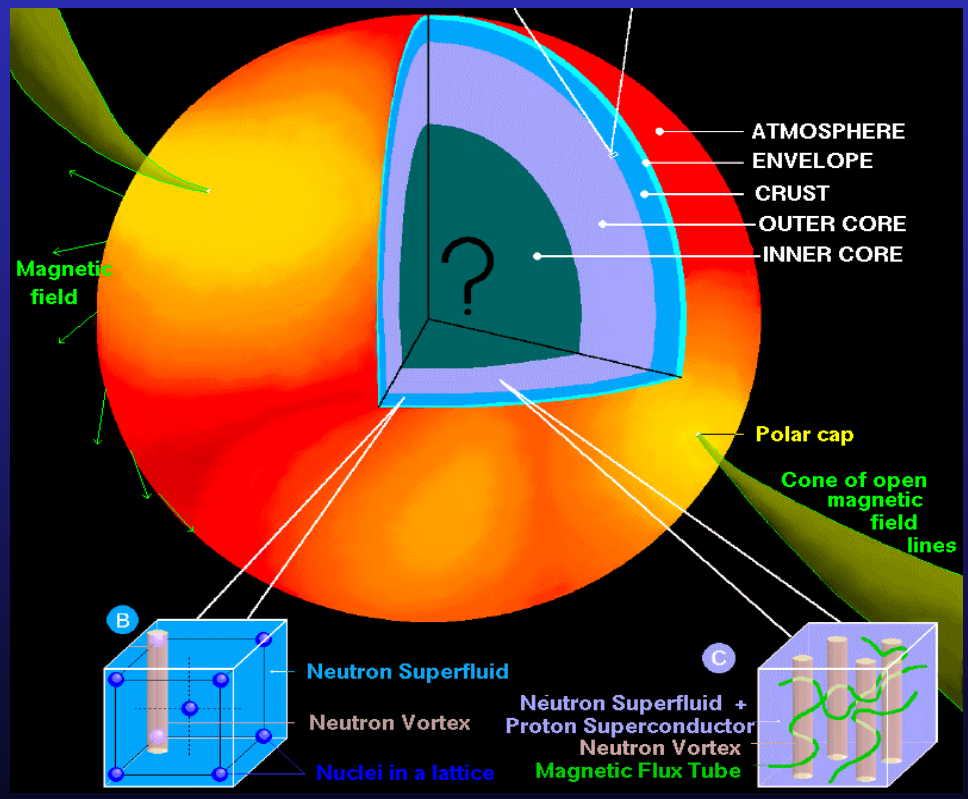
Fundamental interactions: Gravity

- Strong field objects give best test of extreme gravity
- Accreting black holes – emission contains imprint of curvature of spacetime
- Features in X-ray spectra (iron line) and variability (QPO's). Use to test strong gravity and understand accretion in strong gravity.



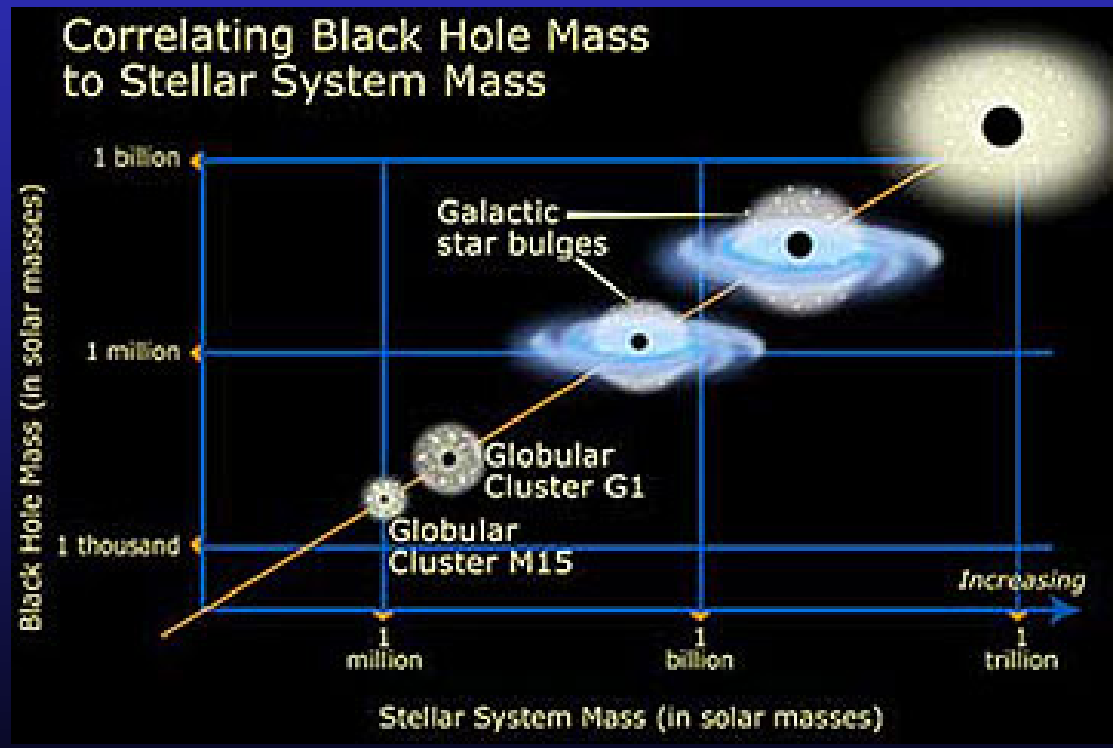
Fundamental interactions: UltraDense Matter

- Neutron stars densities up to 10x nuclear. Strong interaction not well known
- Determines central density, hence mass and radius of the neutron star
- X-ray spectra and variability of neutron stars carry imprint of strength of gravity – mass and radius



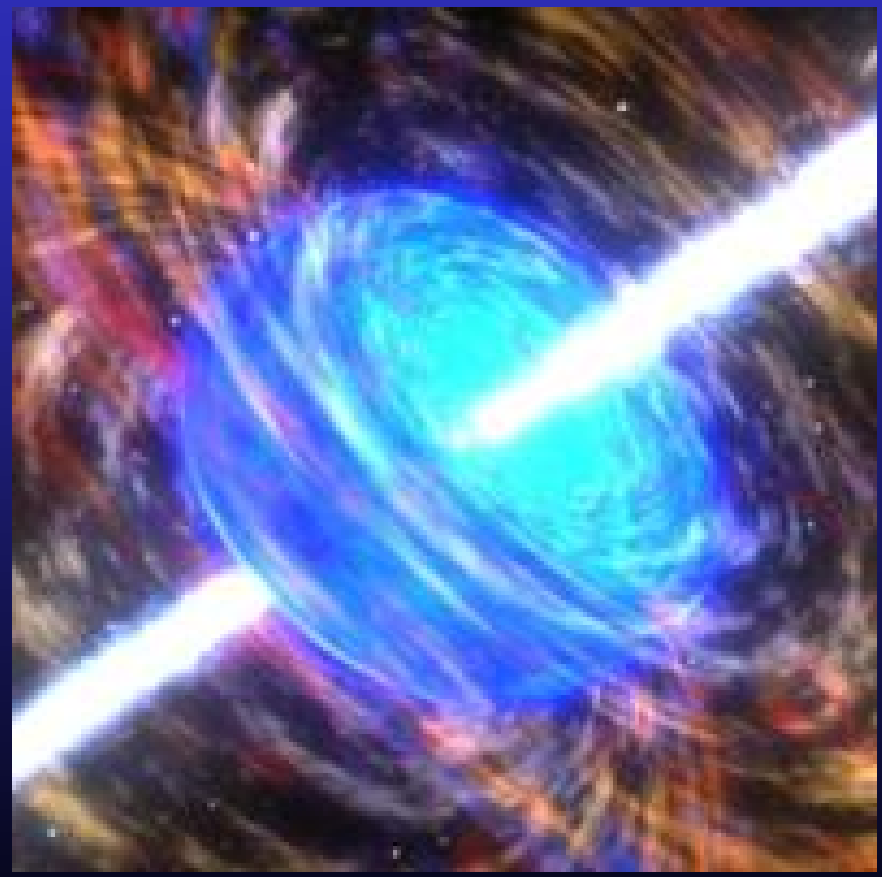
Growth of black holes, stars and galaxies at high z

- Black holes linked to galaxy formation and growth of large scale structure in Universe.
- When did the first black holes form? Massive QSO's seen at z~6.4
- Grow by accretion – observable through X-ray emission and mergers (GW)



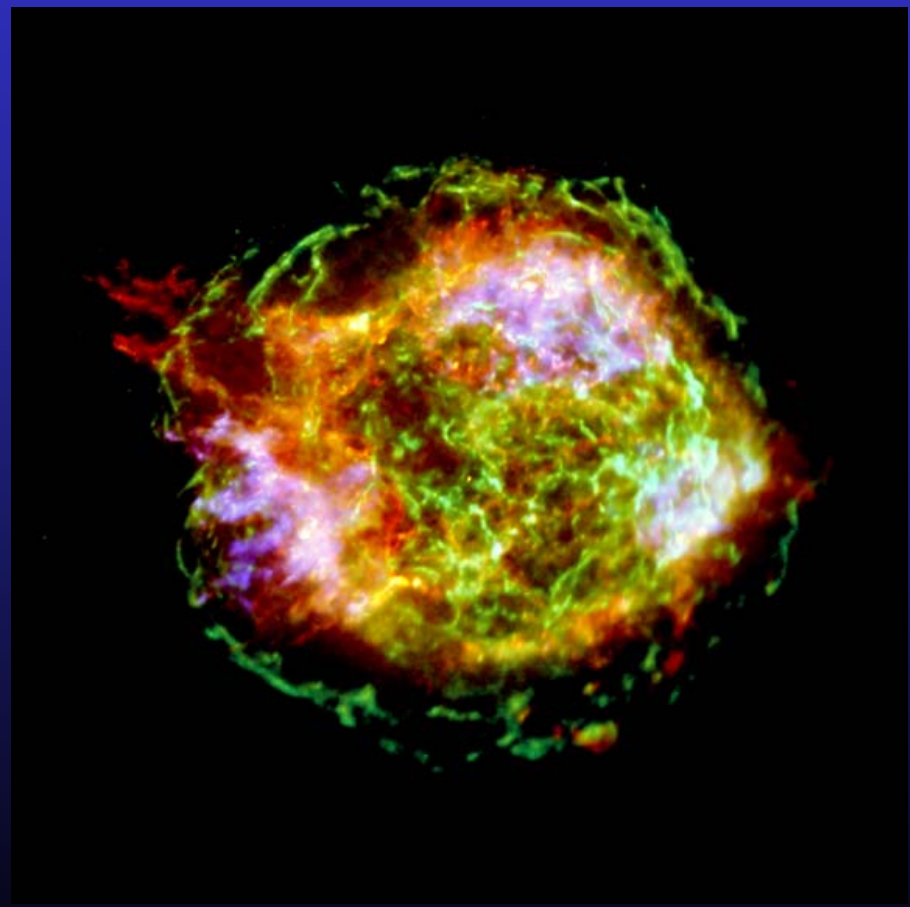
Birth of black holes:supernovae and γRB

- A big breakthrough of last 10 years is identification of γRB as rapid accretion onto newly formed BH (NS mergers or Hypernovae) – burst of γ-ray emission from aligned jet
- Bright so can see at high z – trace evolution of star formation history of the universe – growth of galaxies



Birth of black holes:supernovae and γRB

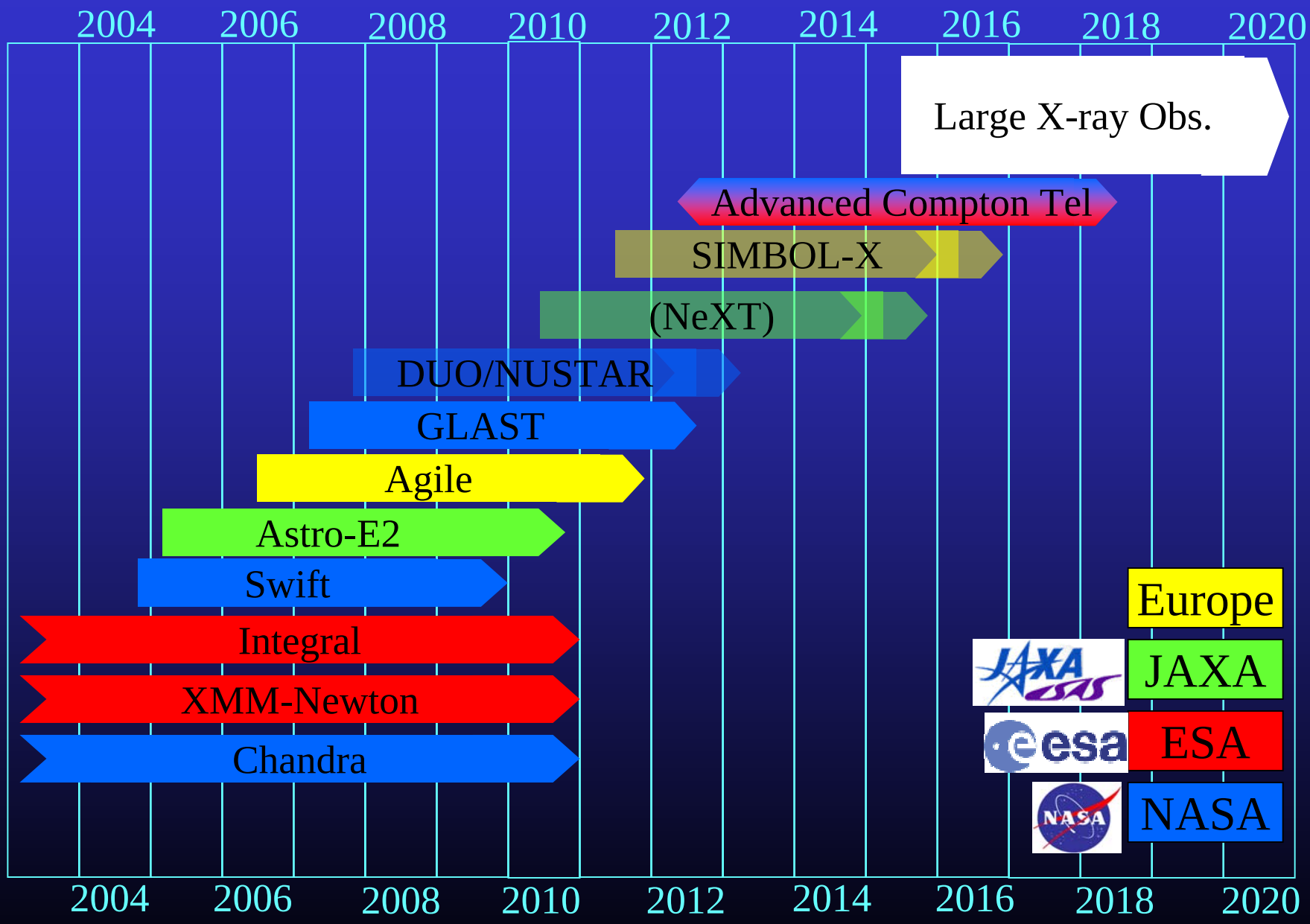
- Disperses heavy elements formed by nucleosynthesis in massive stars
- Track through X-ray lines from γRB afterglow and X-ray and MeV lines from SN remnants.
- Compare to abundances in gas in galaxies/clusters/IGM to understand life cycle of matter in the Universe.



Requirements for a Next Generation X-ray Observatory

- Large area: ~$10m^2$ or 10^{-18} ergs cm^{-2} s^{-1}
- Broad bandpass: ~0.1-100 keV
- High spatial resolution: 2-5 arcsec
- High spectral resolution: 1-2 eV
- Fast detectors: μsec
- Polarimetry

Roadmap: Global context



Conclusions

- Fabulous time!!
- Use violent phenomena in our Universe to test physics under much more extreme conditions than possible on Earth
- Europe has technological breakthroughs
- Large X-ray observatory mission will answer fundamental questions in this field