Faint X-ray sources in globular clusters – an XMM-Newton view

Natalie Webb

&

Didier Barret

Toulouse, France
Globular clusters

- Dense groups of old stars
- Stable on dynamical timescales
- Unstable on thermal timescales

Binaries:
- may be responsible for delaying core collapse
- difficult to detect because of high stellar density
Two types of X-ray source:

- Bright X-ray sources \((L_x > 10^{36} \text{ ergs s}^{-1})\) – X-ray binaries
- Faint X-ray sources \((L_x < 10^{34.5} \text{ ergs s}^{-1})\)

- X-ray binaries
- Cataclysmic variables
- Back-and-forth sources
- Millisecond pulsars
- Active binaries
XMM-Newton

Cameras:
2 x MOS (0.1-12.0 keV)
1 x PN (0.1-15.0 keV)
2 x RGS (0.33-2.5 keV)
1 x OM (optical/UV)

Globular clusters:
- large core radii
- nearby
- low absorption
ω Centauri

RS CVn

CV, bremsstrahlung fit

$kT = 17.3 \pm 6.2$ keV

$\chi^2 = 0.84$ (30 dof)

$L_x = 4.7 \pm 0.2 \times 10^{32}$ erg s$^{-1}$

(0.5-10.0 keV)

Gendre, Barret & Webb (2003a)
$\Gamma = 2.03 \pm 0.21$
Gaussian, centre = 1.0 keV
$L = 8.1 \times 10^{31} \text{ergs s}^{-1}$
$\chi^2 = 1.08, 36$

$\Rightarrow$ Pulsar like 1E1207.4-52

$\text{KS} = 2 \times 10^{-10}$
$\chi^2 = 3 \times 10^{-4}$

Webb et al. (2004)
M 22, optical (U-band) with X-ray error circles

123 220 sources in the optical. 50 X-ray sources
$T_\infty = 76 \pm 3 \text{ eV}$
$R_\infty = 12.8 \pm 0.4 \text{ km}$
with a mass of $1.4 \text{M}_\odot$

$T_\infty = 67 \pm 2 \text{eV}$
$R_\infty = 13.6 \pm 0.3 \text{ km}$
with a mass of $1.4 \text{M}_\odot$

Gendre, Barret & Webb (2003a,b)
Evidence for primordial CVs? 
or 
Evidence for disruption of the cluster?

Webb et al. (submitted)
The most massive galactic globular cluster

Optical study implies two stellar populations

Many sources found outside the half-mass radius

⇒ disruption of the cluster/accretion of a stellar system

(Gendre, Barret & Webb, 2003a, Webb et al., submitted)

NGC 3201: Retrograde motion
  Structure in velocity field of stars
  Excess of sources
  Centrally located but widely spread

(Submitted ??)
Summary

• Faint X-ray sources are many different types of binaries (and fore-/background objects)

• Confirmed Neutron Star Low Mass X-ray Binary (NSLMXB) in ω Cen + detected new one in M 13

• Observations support that NSLMXBs are formed via collisions

• NSLMXBs in globular clusters are excellent objects to eventually constrain the NS equation of state

• Several globular clusters may be somewhat disrupted