

New world of Nuclear Gamma-ray Astrophysics opened with near future X-ray missions

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abstract

New eyes in the hard X-ray to soft gamma-ray band with extremely high sensitivities and energy resolution in future missions, including NeXT satellite, will lead us to a new world of nuclear astrophysics; from elements to nuclear species, and from stable nucleus to unstable ones. One exciting topic is to search for an evidence of the "r-process" nucleosynthesis in the universe. The r-process is the only one process to explain nucleosynthesis of heavier elements than Bi. It occurs only in a explosive neutron-rich environment, like a final stage of supernovae. It is feasible to find some evidence from young supernova remnants by high sensitive search on gamma-ray line emissions from unstable nuclear species produced only by r-process with SGD and HXI on-board NeXT satellite. In this presentation, we will introduce topics on nuclear astrophysics (r-process, ⁵⁶Ni lines from type Ia supernova, ⁴⁴Ti lines from gravitationally collapsed supernova, etc.), which must be important subjects in the next decade with future missions.

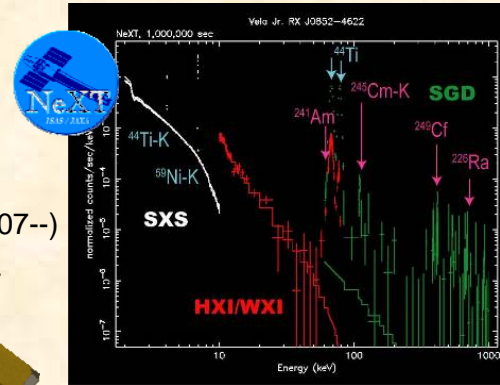
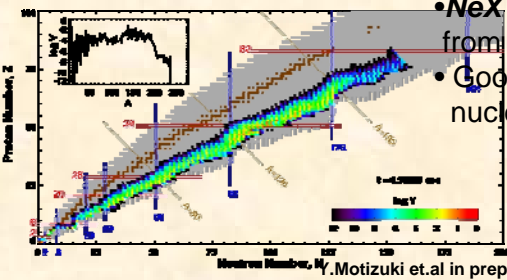
Isotope	Life time	Decay chain	γ-ray Energy (keV)
⁷ Be	77 d	⁷ Be → ⁷ Li*	478
⁵⁶ Ni	8.8 d	⁵⁶ Ni → ⁵⁶ Co* → ⁵⁶ Fe+e+	158, 812; 847, 1238
⁵⁷ Ni	390 d	⁵⁷ Co → ⁵⁷ Fe*	122
²² Na	3.8 yr	²² Na → ²² Ne*+e+	1275
⁴⁴ Ti	89 yr	⁴⁴ Ti → ⁴⁴ Sc* → ⁴⁴ Ca+e+	78, 68; 1157
²⁶ Al	1.0 × 10 ⁶ yr	²⁶ Al → ²⁶ Mg*+e+	1809
⁶⁰ Fe	2.0 × 10 ⁶ yr	⁶⁰ Fe → ⁶⁰ Co* → ⁶⁰ Ni*	59, 1173, 1332
e+	~10 ⁵ yr	e++e- → Ps → γ γ	511, <511

Table.1 Isotopes in the universe →

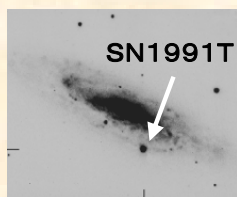
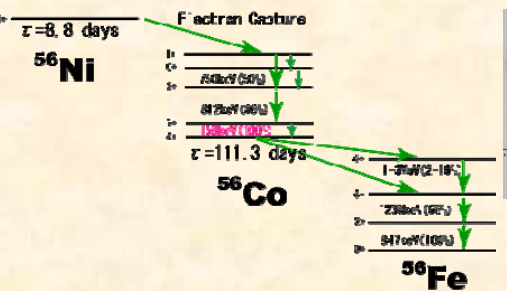
1. Where is the r-process site?

Nucleosynthesis of heavier elements than Bi; Where? How?

- NeXT has high sensitivity to search γ-ray lines from r-processed unstable nucleons. (left)
- Good collaboration with ground experiments of nuclear physics; RIBF (RI beam factory) at RIKEN (2007--)

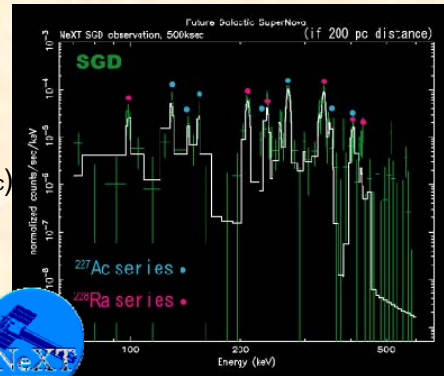


2. What occurs in type Ia Super Novae?

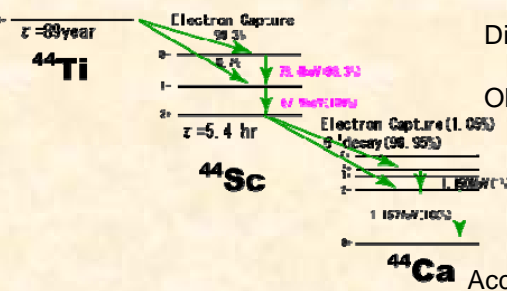


Discovery by COMPTEL (2 events per 9 years; SN1991T@13Mpc, SN1998bu@11Mpc)

NeXT can detect SN Ia from Virgo Cluster (a few events per year)

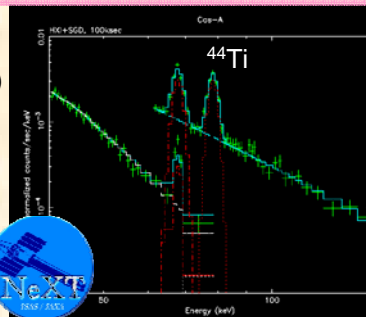


3. Direct probe to Gravitational Collapses in SN



Discovery by COMPTEL (Iyudin 97, Diehl 99)
 Observation vs. Theory many Ground Exp.
 Revise estimation

Accurate measurement by



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