Gamma-ray lines from cosmic nuclei

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Gamma ray lines from cosmic sources display the action of nuclear reactions in cosmic sites. Such gamma rays at characteristic energies result from nuclear transitions following radioactive decays or high-energy collisions with excitation of nuclei. The characteristic gamma-ray line from the annihilation of positrons at 511 keV falls into the same energy window, although of different origin. We present here the concepts of astronomical gamma-ray telescopes and cosmic gamma ray spectrometry, with the corresponding instruments and missions, followed by a discussion of recent results and the challenges and open issues for the future. Among the lessons learned are the diffuse radioactive afterglow of massive-star nucleosynthesis in ^{26}Al and ^{60}Fe gamma rays, which is now being exploited towards the cycle of matter driven by massive stars and their supernovae. Also, constraints on the complex processes making stars explode as either thermonuclear or core-collapse supernovae are being illuminated by gamma-ray lines, in this case from shortlived radioactivities from ^{56}Ni and ^{44}Ti decays. In particular, the non-sphericities that have recently been recognised as important are enlightened in different ways through such gamma-ray line spectroscopy. Finally, the distribution of positron annihilation gamma ray emission with its puzzling bulge-dominated intensity distribution is measured through spatially-resolved spectra, which indicate that annihilation conditions may differ in different parts of our Galaxy.