

# The investigation of the spectra of solar events observed in October-November 2003.

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**Abstract.** More than 30 active regions were observed on the Sun during October-November 2003 by SOHO. Approximately half of such regions induced hard X-ray and  $\gamma$ -ray emission and some solar flares with class M and X were detected during this time by GOES, RHESSI and other experiments. 5 solar flares were detected by AVS-F instrument onboard CORONAS-F satellite. Nuclear  $\gamma$ -emission lines were detected during some flares observed in this period, in particular, during all flares on October 29 2003.

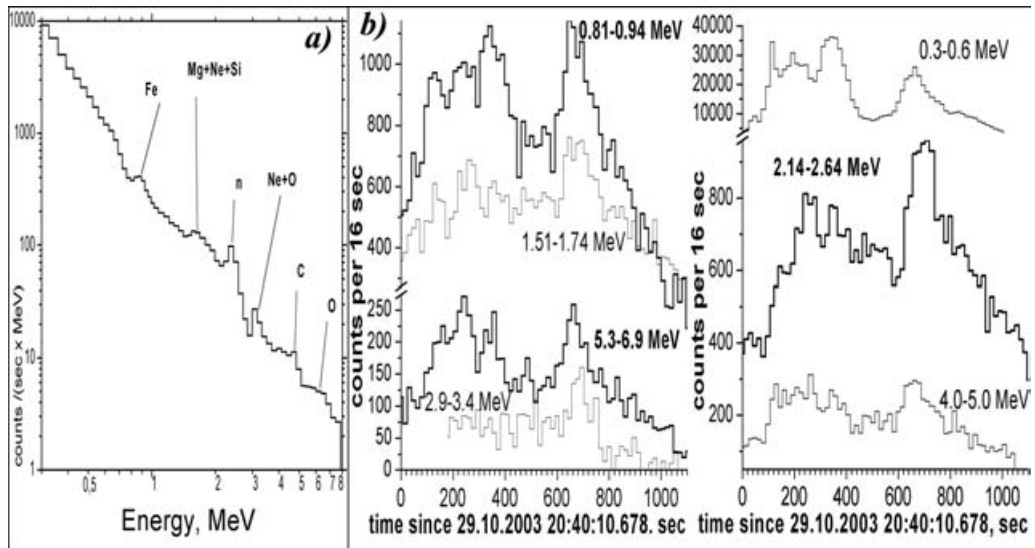
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More than 30 active regions were observed on the Sun during October-November 2003 by SOHO. Four regions (0484, 0486, 0488, 0490) induced hard X-ray and  $\gamma$ -ray emission and 14 solar flares with class M and X were detected during this time by GOES, RHESSI and other experiments. 5 solar flares were detected by AVS-F instrument (apparatus description see Arkhangel'sky (1999)) onboard CORONAS-F satellite. Two of them (23.10.2003 at 08:08:00 UT, 26.10.2003 at 05:57:00 UT) were registered in the polar cap. Flare 04.11.2003 at 19:29:00 were observed both in equatorial region and in polar cap. For one flare (26.10.2003 at 23:37:00 UT) the AVS-F device observed only the end of the flare without significant presence of nuclear  $\gamma$ -lines. Now we conduct more carefully analysis of the spectra of these four flares.

The intensive flare was detected by devices onboard GOES-satellite series (class X10, ball 2B, NOAA region 0486, S15W02, 29.10.2003 from 20:37 to 21:01 UT) (*sec.noaa.gov*) with maximum emission in nuclear  $\gamma$ -lines region. This flare was observed by AVS-F instrument in the equatorial orbit region in 20:39:00-20:58:00 UT. The CORONAS-F satellite came out from radiation belt at 20:39 UT and came in again at 20:58 UT. There are not significant changes in charged particles (electrons in the energy ranges of 0.3-0.6, 0.6-1.5 MeV and 1-5 MeV protons on MKL (Kuznetsov et al. (1995)) data) fluxes affected on the  $\gamma$ -ray temporal profile during this time interval. The spectrum for 20:39:07-20:55:00 UT time interval based on AVS-F data is shown at Figure 1.a. There are 5 nuclear  $\gamma$ -line complexes in this spectrum: 0.81-0.94, 1.51-1.74, 2.9-3.4, 4.0-5.0, 5.3-6.9 MeV corresponding  $^{56}\text{Fe}$ ,  $^{24}\text{Mg}+^{20}\text{Ne}+^{28}\text{Si}$ ,  $^{20}\text{Ne}+^{16}\text{O}$ ,  $^{12}\text{C}$  and  $^{16}\text{O}$  lines accordingly and complex 2.14-2.64 MeV corresponding to neutron capture line. These lines were seen during whole flare. There are some weak lines in the region of 0.3-0.6 MeV ( $e^+e^-$  for example) probably. These  $\gamma$ -lines complexes were observed in the spectra of number solar flares, for example 27.10.1991 (Mandzhavidze & Ramaty (1992)). Figure 1.b shows temporal profiles of 29.10.2003 flare in energy ranges corresponding to mentioned above lines and in continuum 0.3-0.6 MeV by AVS-F data. The temporal profiles of the flare in various energy ranges are different each other. There are some  $\gamma$ -maxima (see Table 1) during this solar flare: at 20:42 UT (in energy ranges corresponding to continuum,  $^{56}\text{Fe}$ ,  $^{24}\text{Mg}+^{20}\text{Ne}+^{28}\text{Si}$  and  $^{12}\text{C}$ ), 20:43 UT (in continuum and  $^{12}\text{C}$  energy ranges), 20:48 UT

**Table 1.** Spectral features of solar flare 29.10.2003 and temporal profile peaks position in the corresponding energy regions on AVS-F data

spectral feature, MeV	line center, MeV	interpretation	peaks position							
0,3-0,6	-	continuum	20:42	20:43	—	20:46	—	20:51	—	
0,81-0,94	0,86	Fe	20:42	—	20:45	20:46	20:48	20:51	—	
1,51-1,74	1,6	Mg+Ne+Si	20:42	—	20:45	20:46	—	20:51	20:52	
2,14-2,64	2,2	n	—	—	20:45	20:46	20:48	20:51	20:52	
2,9-3,4	3,1	Ne+O	—	—	—	—	—	—	20:52	
4,0-5,0	4,2	C	20:42	20:43	20:45	20:46	20:48	20:51	—	
5,3-6,9	6,0	O	—	—	20:45	20:46	20:48	20:51	—	

**Figure 1.** Spectrum in time interval 20:39:07-20:55:00 by AVS-F data (a) and temporal profiles in various energy ranges (b) for solar flare 29.10.2003

(in energy bands corresponding to  $^{56}\text{Fe}$ , n-capture,  $^{12}\text{C}$  and  $^{16}\text{O}$ ) and 20:52 UT (in  $^{24}\text{Mg}+^{20}\text{Ne}+^{28}\text{Si}$ , n-capture and  $^{20}\text{Ne}+^{16}\text{O}$  regions). The maximum at 20:45 UT was observed in all energy ranges except continuum and  $^{20}\text{Ne}+^{16}\text{O}$  line. The maximum at 20:46 UT was observed in all energy ranges too except  $^{20}\text{Ne}+^{16}\text{O}$  line. There were not any maxima in the any energy ranges corresponding to maximum at 20:49:00 UT in soft X-ray data of GOES-12. Indeed there was maximum at 20:48 UT corresponding to one detected in energy range 12-25 keV by RHESSI (*hesperia.gsfc.nasa.gov*). Now we conduct the reconstruction and analysis of the other four flares observed by AVS-F during mentioned above time interval.

## References

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