Chapter 8

Conclusions

8.1 What MACRO Sees

MACRO has been able to detect the two phenomena that must be in the muon sky given standard cosmic ray physics. The ability of MACRO to reconstruct an astronomical source on the sky has been established by the detection of the shadow of the Moon, as described in Chapter 4. No other underground experiment has detected this shadow. In addition, MACRO's sensitivity to small signals has been demonstrated by the detection of the seasonal variation in the absolute muon flux related in Chapter 5. These detections are consistent with both theory and other experiments.

8.2 What MACRO Does Not See

MACRO has examined the muon sky in an unbiased manner for evidence of muon point sources, by looking for any statistically significant DC excesses of muons, as explained in Chapter 6. No such excesses were found. Upper limits to the muon flux observable by MACRO as a function of position in equatorial coordinates have been computed. These limits are almost an order of magnitude lower than those set by MACRO's previous studies[1,2,3].

Muons from the direction of the previously reported muon source of Cyg X-3 have been examined for periodicity in the 4.8h orbital period of this system in Chapter 7. Again, no significant positive signal was detected by MACRO. An upper limit to the modulated muon flux from the direction of Cyg X-3 has been calculated and compared to the fluxes and flux upper limits measured by other experiments.

8.3 Conclusions[2]

While MACRO has been demonstrated as capable of detecting astronomical objects, and the instrument's sensitivity to small variations in the muon flux has been illustrated, MACRO sees no evidence for astrophysical point sources of muons. This is consistent with both standard models of cosmic ray propagation (see Chapter 1), most other underground experiments[4,5,6,7], and previous results from MACRO[1,2,3]. Lack of such a signal contradicts the positive results of the Soudan 1[8,9] and NUSEX[10] experiments. As discussed by Miller[3], this puzzle could be explained by an unusual energy spectrum for the muon parents, and/or by sporadic emission of muon parents over time. However, Occam's razor would argue against invoking several *ad hoc* methods to generate a signal observable in some detectors but not the rest. Rather, it points to the simple solution that nothing physically strange has yet been seen, with the previous measurements being best described as statistical flukes or unexplained systematic errors.

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