

Anisotropy at the end of the cosmic ray spectrum?

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(Received 12 November 2002; published 26 June 2003)

The starburst galaxies M82 and NGC253 have been proposed as the primary sources of cosmic rays with energies above $10^{18.7}$ eV. For energies $\geq 10^{20.3}$ eV the model predicts strong anisotropies. We calculate the probabilities that the latter can be due to chance occurrence. For the highest energy cosmic ray events in this energy region, we find that the observed directionality has less than 1% probability of occurring due to random fluctuations. Moreover, during the first 5 years of operation at Auger, the observation of even half the predicted anisotropy has a probability of less than 10^{-5} to occur by chance fluctuation. Thus, this model can be subject to test at very small cost to the Auger priors budget and, whatever the outcome of that test, valuable information on the galactic magnetic field will be obtained.

DOI: 10.1103/PhysRevD.67.123006

PACS number(s): 98.70.Sa, 98.35.Eg

I. INTRODUCTION

Soon after the microwave echo of the big bang was discovered, Greisen, Zatsepin, and Kuzmin (GZK) noted that the relic photons make the Universe opaque to cosmic rays (CRs) of sufficiently high energy [1]. This occurs, for instance, for protons with energies beyond the photopion production threshold [$\Delta(1232)$ resonance]. After pion production, the proton (or perhaps, instead, a neutron) emerges with at least 50% of the incoming energy. A similar phenomenon (of energy degradation) occurs for nuclei due to processes of photodisintegration. Therefore, the characteristic attenuation length for extremely high energy (10^{20} eV $\leq E \leq 10^{20.5}$ eV) hadrons is less than 100 Mpc, decreasing down to 10 Mpc with rising energy [2]. The survival probability for extremely high energy (EHE) γ rays (propagating on magnetic fields $\geq 10^{-11}$ G) to a distance d , $P(>d) \approx \exp[-d/6.6 \text{ Mpc}]$, becomes less than 10^{-4} after traversing a distance of 50 Mpc [3]. This implies that the GZK sphere [4] represents a small fraction of the size of the universe. Consequently, if the CR sources are universal in origin, the energy spectrum should not extend (except at greatly reduced intensity) beyond $\sim 10^{20}$ eV, a phenomenon known as the GZK cutoff. Even though the Haverah Park [5], Yakutsk [6], Fly's Eye [7], and HiRes [8] data show statistically significant evidence for such a cutoff [9] (more than 5σ independent of the sample used as a basis for extrapolation), the Akemo Giant Air Shower Array (AGASA) detected a handful of events with energies $\geq 10^{20}$ eV [10], as opposed to about 2 expected from the GZK cutoff. Moreover, within statistical uncertainty (which is large above 10^{20} eV) the flux of CRs above $10^{18.7}$ eV reported by the AGASA Collaboration [10] is consistent with a $E^{-2.7}$ spectrum up to the highest observed energies, suggesting that a single acceleration mechanism is responsible for all the events beyond that energy, unless of course a very unlikely matching of spectra can account for the smoothness of the CR energy distribution.

In order to analyze the effect of energy losses on the observed spectrum, it is convenient to introduce the accumula-

tion factor f_{acc} , defined as the ratio of energy-weighted fluxes for “low” ($10^{18.7}$ eV– $10^{19.5}$ eV) and EHECRs. With this in mind, if the Earth is located in a typical environment and all CR sources have smooth emission spectra, the observed spectrum above $10^{18.7}$ eV should have an offset in normalization between low and EHE given by f_{acc} . For CR protons and nuclei with uniform distribution of sources active over cosmological times, the cutoff due to photopion and photodisintegration processes relates the accumulation factor to a ratio of attenuation lengths [11] and leads to $f_{\text{acc}} \sim 100$. The smoothness of the observed CR spectrum [10], *viz.* $f_{\text{acc}} \sim 1$, seems to indicate that the power of nearby sources must be comparable to that of all other sources (redshift $z > 0.5$) added together.

The simplest explanation, *i.e.*, nearby sources are significantly more concentrated, does not seem to be the case. Specifically, if one simply assumes that the distribution of CR sources follows the distribution of normal galaxies, the local overdensity is only a factor of two above the mean, and thus insufficient to explain the measured flux above 10^{20} eV [12]. Furthermore, the arrival direction of the super-GZK events is consistent with an isotropic distribution of sources (even when some level of clustering was already detected [13]), in sharp contrast to the anisotropic distribution of light within 100 Mpc [14]. A way to avoid the problems with finding plausible astrophysical explanations is to look for solutions involving physics beyond the standard model [15]. While the invocation of such new physics is an intriguing idea, there are now constraints that call into question the plausibility of some of these ideas [16].

Recently, it was suggested that the observed near-isotropy of arrival directions could be due to a diffuse propagation of EHECRs [17]. In this work, we examine specific candidate sources for this hypothesis. These are the starburst galaxies M82 and NGC253 which have been shown to reproduce the main features of the observed flux [18]. In particular, we study here the critical aspect of a residual anisotropy that emerge beyond the GZK energy limit after deflection in galactic and extragalactic magnetic fields. Specifically, we es-

timate the probability that an apparent correlation between the arrival directions of the highest energy events and the two starbursts can originate as a purely random fluctuation. After that, we study the sensitivity of the Pierre Auger Observatory to the model.

II. DIFFUSE PROPAGATION OF COSMIC RAYS IN A MAGNETIZED NEIGHBORHOOD OF THE GALAXY

A popular explanation considered recently [17] for an isotropic distribution of arrival directions entertains the existence of large scale intervening magnetic fields, so that even EHECRs propagate diffusively. Indeed, there are some measurements of diffuse radio emission from the bridge area between Coma and Abell superclusters that under assumptions of equipartition allows an estimate of 0.2–0.6 μG for the magnetic field in this region [19]. Such a strong magnetic field (which is compatible with existing upper limits on Faraday rotation measurements [20]) could be possibly understood if the bridge region lies along a filament or sheet of large scale structures [21]. In light of this, it appears plausible, though subject to verification, to assume that our Local Supercluster contains a large scale magnetic field (say, $10^{-8} \text{ G} \leq B \leq 10^{-6} \text{ G}$ [22]) which provides sufficient bending to EHECR orbits, camouflaging the exact location of the sources.

Diffusion has two distinctive regimes. Particles that are trapped inside magnetic subdomains (of size $\ell_{\text{Mpc}} \equiv \ell/\text{Mpc}$) follow Kolmogorov diffusion. In such a case, the functional dependence of energy of the diffusion coefficient (for protons) is found to be [23]

$$D(E) \approx 0.048 \left(\frac{E_{20} \ell_{\text{Mpc}}^2}{B_{\mu\text{G}}} \right)^{1/3} \text{ Mpc}^2/\text{Myr}, \quad (1)$$

where $B_{\mu\text{G}}$ is the magnetic field strength in units of μG and E_{20} is the particle's energy in units of 10^{20} eV . With rising energy, the Larmor radius of the particles starts approaching ℓ and there is a transition to Bohm diffusion. The diffusion coefficient in this regime is of order the Larmor radius times velocity ($\sim c$).

If CRs propagate diffusively, the radius of the sphere for potential proton sources becomes significantly reduced. This is because one expects negligible contribution to the flux from times prior to the arrival time of the diffusion front, and so the average time delay in the low energy region,

$$\tau_{\text{delay}} \approx \frac{d^2}{4D(E)}, \quad (2)$$

must be smaller than the age of the source, or else the age of the universe (if no source within the GZK radius is active today, but such sources have been active in the past). Note that the diffuse propagation of EHE protons requires magnetic fields $\sim 1 \mu\text{G}$. Therefore, for typical coherence lengths of extragalactic magnetic fields ($\ell \sim 1 \text{ Mpc}$) the time delay of CRs with $E \approx 10^{18.7} \text{ eV}$ cannot exceed $\tau_{\text{delay}} \lesssim 14 \text{ Gyr}$, yielding a radius of $d \sim 30 \text{ Mpc}$. In the case CR sources are active today, the radius for potential sources is even smaller

TABLE I. The highest energy cosmic rays. The energy resolution for the AGASA experiment was taken from Ref. [10].

| Date | Experiment | E [EeV] | l | b | Ref. |
|----------|------------|---------------------|---------------|---------------|------|
| 89/05/07 | Yakutsk | 300_{-178}^{+100} | 162.0° | 2.0° | [25] |
| 91/10/15 | Fly's Eye | 320 ± 90 | 163.4° | 9.6° | [26] |
| 93/12/03 | AGASA | 213 ± 75 | 130.5° | -41.4° | [27] |
| 01/05/10 | AGASA | 280 ± 98 | 106.3° | -39.0° | [28] |

$d \sim 5 \text{ Mpc}$. Centaurus A, at a distance of 3.4 Mpc and galactic coordinates $l = 310^\circ$, $b = 20^\circ$, is the nearest active galaxy, and the only one within a distance of 5 Mpc. Phenomenological arguments identify Centaurus A as a plausible progenitor of all CRs observed on Earth with energies $\geq 10^{18.7} \text{ eV}$ [11,24]. However, detailed numerical simulations seem to indicate that large scale magnetic fields $\mathcal{O}(\mu\text{G})$ cannot provide sufficient angular deflection to explain all the observational data: (1) the large deflection angle of the highest energy event recorded by the Fly's Eye experiment (see Table I) with respect to the line of sight to Centaurus A must be explained as a 2σ fluctuation [29], (2) for an emission spectrum $\propto E^{-2.4}$ and maximum injection energy of 10^{21} eV , the angular power spectrum shows a 3σ quadrupole deviation from AGASA observations [30].

If magnetic fields in the nanogauss range exist in the neighborhood of the Galaxy, it is possible that ultrahigh energy cosmic ray nuclei could diffuse sufficiently in order to attain the observed near isotropy. For a CR nucleus of charge Ze in a magnetic field $B_{\text{nG}} \equiv B/10^{-9} \text{ G}$, the Larmor radius is

$$R_L \approx \frac{100 E_{20}}{Z B_{\text{nG}}} \text{ Mpc}. \quad (3)$$

In this case, the sphere of potential sources is severely constrained by the GZK cutoff: less than 1% of iron nuclei (or any surviving fragment of their spallations) can survive more than $3 \times 10^{14} \text{ s}$ with an energy $\geq 10^{20.5} \text{ eV}$. Therefore, the assumption that EHECRs are heavy nuclei implies ordered extragalactic magnetic fields $B_{\text{nG}} \lesssim 15\text{--}20$, or else nuclei would be trapped inside magnetic subdomains suffering catastrophic spallations. There are two candidate sources within the GZK sphere; namely, the nearby ($d \sim 3 \text{ Mpc}$) metal rich starburst galaxies M82 ($l = 141^\circ$, $b = 41^\circ$) and NGC253 ($l = 89^\circ$, $b = -88^\circ$) [31]. Phenomenological considerations based on analytical estimates of the diffusion coefficient and approximations to the photodisintegration losses and angular deflections suggest that the power of these starbursts is enough to provide all CRs observed on Earth above $10^{18.7} \text{ eV}$ [18]. This analytical study is consistent with Monte Carlo simulations [32]. Specifically, the spectrum observed by AGASA can be fitted with a single source located at $d = 3.2 \text{ Mpc}$ if the spectrum of nuclei is $\propto E^{-1.6}$. This is a hard spectrum compared to the expected E^{-2} from the Fermi mechanism. In this context, it should be noted that the fit in [32] has strong statistical weight from points near 10^{19} eV . However, there is significant systematic uncertainty in the observed energy spectrum in this region. For example, as

recently noted [9], a downward shift of 11% in the AGASA energy calibration is required in order to bring the resulting spectrum into agreement with Fly's Eye data. This softening of the observed energies will require a steeper Fermi-like injection spectrum.

The most salient feature of the starburst hypothesis is the prediction of an anisotropy at the high end of the spectrum. For an extragalactic, smooth, magnetic field of $\approx 15\text{--}20$ nG, diffusive propagation of particles below 10^{20} eV evolves to nearly complete isotropy in the CR arrival directions [18,32]. Above this critical energy there is a transition range (up to $10^{20.3}$ eV) where the combined bending in extragalactic and galactic magnetic fields leads to loss of directionality. With rising energy, the average deflection in the extragalactic magnetic field is significantly reduced, and is roughly $10^\circ \lesssim \theta \lesssim 20^\circ$ in the energy range $10^{20.3}$ eV $\lesssim E \lesssim 10^{20.5}$ eV [32]. In order to incorporate typical uncertainties in energy resolution as well as those in the Monte Carlo simulation [32], we will increase the upper limit of this deflection to 30° . Heavy nuclei suffer additional deflection in the galactic magnetic field.

The large scale structure of the galactic magnetic field carries substantial uncertainties, because the position of the solar system does not allow global measurements. The average field strength can be directly determined from pulsar observations of the rotation and dispersion measures average along the line of sight to the pulsar with a weight proportional to the local free electron density, $\langle B_{\parallel} \rangle \approx 2 \mu\text{G}$ [33]. Measurements of polarized synchrotron radiation as well as Faraday rotation of the radiation emitted from pulsars and extragalactic radio sources revealed that the global structure of the magnetic field in the disk of our Galaxy could be well described by spiral fields with 2π (axisymmetric, ASS) or π (bisymmetric, BSS) symmetry [34]. In the direction perpendicular to the galactic plane the fields are either of odd (dipole type) or even (quadrupole type) parity. Discrimination between these models is complicated. Field reversals are certainly observed (in the Crux-Scutum arm at 5.5 kpc from the galactic center, the Carina-Sagittarius arm at 6.5 kpc, the Perseus arm at 10 kpc, and possibly another beyond [35]). However, as discussed by Vallée [36], turbulent dynamo theory can explain field reversals at distances up to ~ 15 kpc within the ASS configuration. Interestingly, if the galactic field is of the ASS type, CRs entering the Galaxy with $l < 180^\circ$ are deflected towards increasing values of l and decreasing values of $|b|$ [37]. Consequently, as we show in what follows, each arrival direction given in Table I can be traced backwards to one of the starbursts.

The field strength in the galactic plane ($z=0$) for the ASS model is generally described by [37]

$$B(\rho, \theta) = B_0(\rho) \cos^2[\theta - \beta \ln(\rho/\xi_0)], \quad (4)$$

where θ is the azimuthal coordinate around the galactic center (clockwise as seen from the north galactic pole), ρ is the galactocentric radial cylindrical coordinate, and

$$B_0(\rho) = \frac{3r_0}{\rho} \tanh^3(\rho/\rho_1) \mu\text{G}. \quad (5)$$

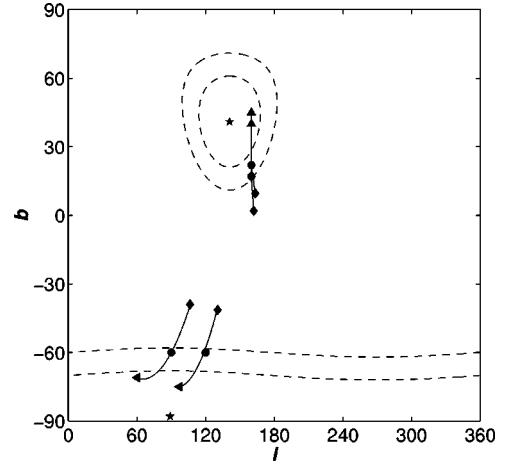


FIG. 1. Directions in galactic coordinates of the four highest energy cosmic rays at the boundary of the galactic halo. The diamonds represent the observed incoming directions. The circles and arrows show the directions of neon and iron nuclei, respectively, before deflection by the galactic magnetic field. The solid line is the locus of incoming directions at the halo for other species with intermediate atomic number. The stars denote the positions of M82 and NGC253. The dashed lines are projections in the (l, b) coordinates of angular directions within 20° and 30° of the starbursts.

Here, $\xi_0 = 10.55$ kpc stands for the galactocentric distance of the maximum of the field in our spiral arm, $\beta = 1/\tan p$ (with the pitch angle, $p = -10^\circ$), $r_0 = 8.5$ kpc is the Sun's distance to the galactic center, and $\rho_1 = 2$ kpc. The θ and ρ coordinates of the field are correspondingly,

$$B_\theta = B(\rho, \theta) \cos p, \quad B_\rho = B(\rho, \theta) \sin p. \quad (6)$$

The field strength above and below the galactic plane (i.e., the dependence on z) has a contribution coming from the disk and another from the halo,

$$B(\rho, \theta, z) = B(\rho, \theta) \tanh(z/z_3) \times \left(\frac{1}{2 \cosh(z/z_1)} + \frac{1}{2 \cosh(z/z_2)} \right), \quad (7)$$

where $z_1 = 0.3$ kpc, $z_2 = 4$ kpc and $z_3 = 20$ pc. Figure 1 shows the extent to which the observed arrival directions of the CRs listed in Table I deviate from their incoming directions at the galactic halo because of bending in the magnetic field given in Eq. (7). The incoming CR trajectories are traced backwards up to distances of 20 kpc away from the galactic center, where the effects of the magnetic field is negligible. The diamond at the head of each solid line denotes the observed arrival direction, and the points along these lines indicate the direction from which different nuclear species (with increasing mass) entered the galactic halo. In particular, the tip of the arrows correspond to incoming directions at the halo for iron nuclei, whereas the circles correspond to nuclei of neon. Additionally shown in the figure, indicated by stars, is the location of the two starbursts. Regions within the dashed lines comprise directions lying within 20° and 30° degrees of the starbursts. It is seen that

trajectories for CR nuclei with $Z \geq 10$ can be further traced back to one of the starbursts, within the uncertainty of the extragalactic deviation.

The trajectories in Fig. 1 result from motion in the regular component of the galactic magnetic field. However, there is some evidence supporting the existence of a random component roughly comparable in magnitude to the regular component [38]. Thus, using the random walk formulation [39] with coherence lengths of ~ 1 kpc, we estimate that the trajectories should be broadened by an angle $\delta\vartheta \sim 40^\circ (Z/20)$. The effect of this broadening on our analysis will be further discussed in the following section.

The effects of the BSS configuration are completely different. Because of the averaging over the frequent field reversals, the resulting deviations of the CR trajectories are markedly smaller, and in the wrong direction for correlation of current data with the starburst sources. We note that the energy-ordered 2D correlation distribution of the AGASA data is in disagreement with expectations for positively charged particles and the BSS configuration [40].

III. ASSESSMENT OF RANDOM COINCIDENCES

We now attempt to assess to what extent these correlations are consistent with chance coincidence. To do so, we first observe that the angular deviation of a CR arrival direction at the outer edge of the galaxy with respect to the straight line of sight is roughly

$$\theta \approx 0.3^\circ \frac{d}{\text{kpc}} \frac{\langle B_{\parallel} \rangle}{\mu\text{G}} \frac{Z}{E_{20}}. \quad (8)$$

Hence, for $d \approx 5-10$ kpc, the average deflection of heavy nuclei with energies in the range $10^{20.3}$ eV $\leq E \leq 10^{20.5}$ eV is $30^\circ \leq \theta \leq 40^\circ$. We arrive at the effective angular size of the source in a two-step process. Before correcting for bias due to the coherent structure of the galactic magnetic field, the deflections in the extragalactic and galactic fields (regular and random components) may be assumed to add in quadrature, so that the angular sizes of the two sources are initially taken as cones with opening half-angles between 40° and 60° , which for the purpose of our numerical estimate we approximate to 50° . However, the global structure of the field will introduce a strong bias in the cosmic ray trajectories, substantially diminishing the effective solid angle. The combined deflections in the l and b coordinates mentioned above concentrate the effective angular size of the source to a considerably smaller solid angle [37]. As a conservative estimate, we retain 25% of this cone as the effective source size. A clear prediction of this consideration is that *the incoming flux shows a strong dipole anisotropy in the harmonic decomposition*.

In order to assess the likelihood of a random occurrence of the predicted spatial distribution we performed numerical simulations in the spirit of Ref. [41]. By randomly generating four CR positions in the portion of the sky accessible to the existing experiments (declination range $\delta > -10^\circ$), an expected number of random coincidences can be obtained. The term ‘‘coincidence’’ is herein used to label a synthetic CR

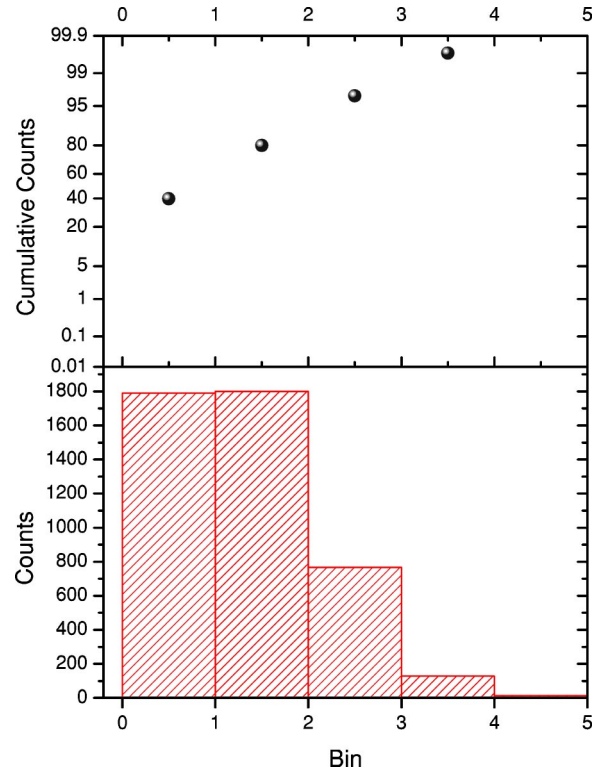


FIG. 2. Simulation results for 4500 trials (a larger number of trials do not modify these results). 99% of the simulations yield results with less than 4 random coincidences, as described in the text.

whose position in the sky lies within an effective solid angle Ω_{eff} of either starburst. Ω_{eff} is characterized by a cone with opening half-angle reduced from 50° to 24° to account for the 75% reduction in effective source size due to the magnetic biasing discussed above. Cosmic ray positional errors were considered as circles of 1.6° radius for AGASA. For the other experiments the asymmetric directional uncertainty was represented by a circle with radius equal to the average experimental error. Figure 2 presents the simulation results. There are, as we have seen, four real coincidences. However, the random prediction for the mean number of coincidences is 0.81 ± 0.01 [42]. The Poisson probability [43] for the real result to be no more than the tail of the random distribution is just

$$P(\geq 4) = \sum_{k=4}^{\infty} \frac{\lambda^k \exp^{-\lambda}}{k!} = 9 \times 10^{-3}, \quad (9)$$

where λ is the mean value of the random results. Alternatively, we may analyze this in terms of confidence intervals. For the four observed events, with zero background, the Poisson signal mean 99% confidence interval is 0.82–12.23 [44]. Thus our observed mean for random events, 0.81 ± 0.01 , falls at the lower edge of this interval, yielding a 1% probability for a chance occurrence.

We now discuss the implications of our results. Clearly, spatial correlation analysis with a well defined and large sample of CR positions ought to provide the key to the iden-

tification of EHECR sources. The result embodied in Eq. (9) is not compelling enough to definitively rule out chance probability as generating the correlation of the observed events with the candidate sources, but it is suggestive enough to deserve serious attention in analyses of future data. Besides, it should be stressed that the starburst hypothesis predicts a spectrum which is approximately a smooth power law between $10^{18.7}$ eV and $10^{20.5}$ eV, in very good agreement with that reported by the AGASA Collaboration [18]. In addition, we note that a medium mass nucleus fits the shower profile of the highest energy Fly's Eye event quite well [45]. Moreover, the high muon density observed in the Yakutsk event also favors a nucleus primary [25].

IV. LOW BUDGET ANISOTROPY TARGET FOR THE HIGHEST ENERGY COSMIC RAYS

The superior angular and energy resolution of the Pierre Auger Observatory [46] will allow the high end of the energy spectrum and the CR arrival directions to be measured with unprecedented precision. The protocols for testing anisotropy detection claims are being restricted to hypotheses that must be specified *a priori* in order to ensure: (1) that the sample is not (inadvertently) devised to suit a special hypothesis after a preliminary study of the data, and (2) that the number of potential sources is not so large that the criterion for negating the null hypothesis for any source is reasonable [47]. Since the budgeting for candidate sources of anisotropy is very constrained (total random probability after accounting for all relevant trials is less than 0.001) particular emphasis should be put, in our view, to those models in which there is no new physics involved, and a plausible astrophysical mechanism is suggested as the origin of some or all events. Some examples are: the above mentioned Centaurus A, nearby quasar remnants [48], and luminous infrared galaxies [49]. In this direction, we believe the reasons we just listed above are sufficient to encourage the Auger community to search for evidence of the starburst model in forthcoming measurements.

We now estimate the sensitivity of Auger to our model. The event rate for the Southern Auger Observatory (a detector with aperture $A = 7000$ km² sr above 10^{19} eV, and angular resolution less than 1.5° with $\delta < 20^\circ$), assuming extrapolation of AGASA flux $[E^3 J(E) \approx 10^{24.5}$ eV² m⁻² s⁻¹ sr⁻¹ [10]] up to $10^{20.5}$ eV, is given by

$$\begin{aligned} \frac{dN}{dt} &= A \int_{E_1}^{E_2} E^3 J(E) \frac{dE}{E^3} \\ &\approx \frac{A}{2} \langle E^3 J(E) \rangle \left[\frac{1}{E_1^2} - \frac{1}{E_2^2} \right] \\ &\approx 5.3 \text{ yr}^{-1}, \end{aligned} \quad (10)$$

where $E_1 = 10^{20.3}$ eV and $E_2 = 10^{20.5}$ eV. We now consider a 5-year sample of 25 events, and note that for the energy range under consideration the aperture of Auger is mostly receptive to cosmic rays from NGC253. We allow for different possibilities of the effective reduction of the cone size

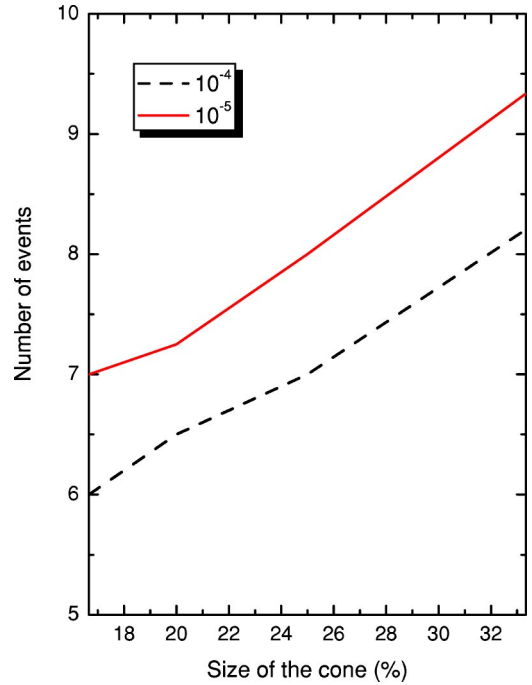


FIG. 3. Curves of constant probabilities in the two-dimensional parameter space defined by the size of the cone and the minimum number of events originating within the resulting effective solid angle.

because of the galactic magnetic field biasing discussed previously. In Fig. 3 we plot contours of constant probabilities ($P = 10^{-4}, 10^{-5}$) in the two-dimensional parameter space of the size of the cone (as a fraction of the full 50° circle) and the minimum number of events originating within the resulting effective solid angle. Several important conclusions may be drawn. First, there is very little sensitivity of the results to the size of the cone, the variation is less than 20% for a 50% reduction in the cone size. Secondly, the model predicts that after 5 years of operation, *all* of the 25 highest energy events would be observed in the aperture described above. From Fig. 3 we can see that even if 7 or 8 are observed, this is sufficient to rule out a random fluctuation at the 10^{-5} level. Thus, the disproof of the starburst hypothesis can be achieved at a very small cost, $< 10^{-5}$ out of a total 10^{-3} to the Auger probability budget. Current preliminary assignments for other hypotheses are on the order of 10^{-4} [47].

V. CONCLUSION

We have made a definite prediction for future observations at the Auger Observatory: if the origin of CRs above $10^{18.7}$ eV is nearby starburst galaxies, *the incoming CR flux will show a strong dipole anisotropy in the harmonic decomposition at energies beyond $10^{20.3}$ eV*. Because of its well-defined prediction, the model can be tested at the 5σ level in five years of running at Auger. Therefore, we strongly recommend that the Auger Collaboration take into account the next-door galaxy NGC253 in their first anisotropy prescription for super-GZK CRs. The confirmation of the starburst hypothesis would provide, as spinoff, direct evidence for the global structure of the galactic magnetic field.

ACKNOWLEDGMENTS

The work of L.A.A. and H.G. has been partially supported by the U.S. National Science Foundation (NSF), under grants

No. PHY-0140407 and No. PHY-0073034, respectively. The work of D.F.T. was performed under the auspices of the U.S. Department of Energy by University of California Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

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