Dust in the South Coma Void?

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The results of recent studies of the South Coma Void are compared with previous searches for intergalactic matter in the same region. Infrared 100 μm emission from the central part of the void yields a good argument in favour of the presence of dust in this large void.

Keywords: Intergalactic medium, infrared radiation

Introduction

Numerous studies based on two- and three-dimensional surveys of large-scale structures in the Universe indicate inhomogeneous distribution of matter on the scale of galaxies and clusters of galaxies. Voids in the distribution of galaxies in three dimensions (2D → celestial coordinates, 1D → redshift) are well observed, yet our knowledge of the general matter content in regions devoid of bright galaxies is sparse. Sometimes voids are considered to be essentially empty regions. More detailed investigations seem to indicate the existence of some matter in the voids.

In the Bootes void, *e.g.*, several faint emission line galaxies have been detected (Moody *et al.* 1987, Weistrop 1989). Gondhalekar and Brosch (1986) observed Lyα, Si IV and C IV absorption lines in background quasars in the regions of the Bootes and Perseus-Pisces voids. The redshifts of the lines indicate that they originate in these voids. In the present paper, the possible presence of dust in the South Coma Void is suggested.

Observations

The South Coma Void is identical with the "Okroy Cloud" (Okroy 1965). Of the less than ten intergalactic dust clouds postulated thus far, only the Okroy Cloud region has been well studied.

Extinction and reddening. The Okroy Cloud was first noticed as a large area (150 square degrees) with a visible lack of galaxies in the distribution from the Zwicky catalogue. Murawski (1983) suggested that the shortage is due to an obscuring cloud of intergalactic nature, rather than a fluctuation in the distribution of galaxies. He showed that the *N(m)*-curve of galaxies in the direction of the cloud is partially shifted towards fainter stellar magnitudes (Wolf-diagram) as compared to a control region. He also noticed that the galaxy colours in the cloud area are redder and that the ratio of blue/red galaxy sizes is lower than in the surrounding parts. Analyzing the distribution of the RR Lyrae stars, Murawski found that the cloud lies beyond the galactic halo.

It should be mentioned that the break in the Wolf-diagram, the redder average colours and the smaller blue sizes of the galaxies can in principle be equally well explained by a missing galaxy population at intermediate z-values, such as occurs in a void. It simply indicates that the more distant and, on average, redder galaxies contribute relatively more to the total sample. The numerical results due to the two effects may be quite different and are strongly dependent on the distance and size of the void. In the most general case, the two effects occur together.

Redshift analysis. The presence of a large void in redshift space in the region of the Okroy Cloud has recently been supported by extensive redshift measurement by Tifft and Gregory (1988). The authors show that a region of about 110 square degrees at velocities 5000 to 6000 $km\ sec^{-1}$ is quite empty of galaxies with $m_p \leq 15.7$. This corresponds to an absolute magnitude limit of $M_B \cong -18.5 + 5 \log h$ at the centre of the void (located at $d = 73\ Mpc$ for $H_0 = 75\ km\ sec^{-1} Mpc^{-1}$). The authors do not exclude the presence of faint galaxies within the voids. Their existence would, however, make the luminosity function quite abnormal.

Far-infrared emission. Pierce and Tully (1985) suggested that 100 μm emission from intergalactic clouds should be detectable by IRAS if the gas/dust ratio in such clouds was comparable to that in our galaxy, while heating was provided by UV radiation from surrounding galaxies.

Wszołek *et al.* (1988) have carried out an analysis of the Okroy Cloud using IRAS all sky maps. They have found:

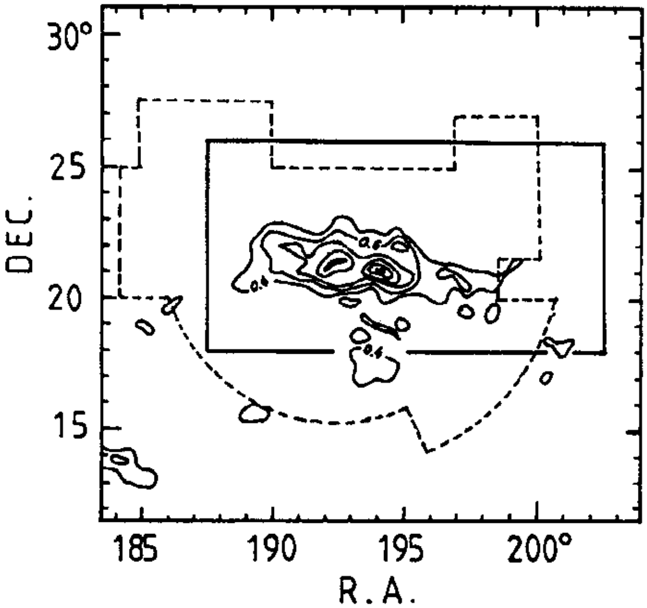

Figure 1
100 μm emission (IRAS-HCON 1 data) after subtraction of a power fit surface to the background. The isophotes have been drawn at levels between 0.2 and 1.4 mJy/sr, with 0.2 mJy/sr increments. The dashed line is the boundary of the Okroy Cloud (Muraski 1983), and the solid rectangle represents the area of the South Coma Void (Tifft and Gregory 1988).

- in the central part of the cloud region (about 30 square degrees) noticeable enhancement of the 100 μm radiation is present (see Figure 1).
- the maximum of the 100 μm emission coincides well with the centre of the Okroy cloud.
- the maximum of the 100 μm emission in the cloud is 1.3 ± 0.2 mJy/sr.
- in the 60 μm, 25 μm and 12 μm bands, no emission enhancement is observed. This indicates that the temperature is less than 20° K.

Discussion

The observed distributions (two-dimensionally, in redshift space, and in magnitude), the mean colours and the ratio of blue to red galaxy sizes as compared to those in surrounding regions are all in agreement with the existence of a large void between the Virgo and Coma clusters of galaxies plus the possible existence of dust. Infrared observations suggest that cold dust is present. The 100 μm radiation has a clear maximum near the centre of the void and could extend to the outer parts, where the presently available infrared signals are too weak to be distinguished from noise. While dust absorption as the sole cause of the lack of galaxies in this region can be ruled out, the presence of dust in the direction and possibly at the distance of a well-established void appears to be of great importance.

The South Coma Void lies between two rich clusters of galaxies. They may be the source of the dust, and possibly of gas, if UV observations should reveal similar lines as in the Bootes and Perseus-Pisces voids. The simultaneous presence of highly ionized gas of some of the major constituents of the dust (C, Si) and very cold dust would then have to be explained.

Conclusion

Optically identified "intergalactic clouds" may partially be artifacts due to the presence of voids between galaxies. The voids, however, can be associated with gas visible in the UV and dust observable in the far infrared. Selective dust absorption could then contribute to the observed average colours and sizes of galaxies seen beyond the void, while additional changes in the mean colours and sizes are due to the missing void population. In order to estimate the relative contributions to these effects, more data are needed. The origin and sustenance of intergalactic matter in voids poses challenging problems and may ultimately force us to abandon or substantially change the Standard Model.

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