surpasses so much the absorption of an equal mass of scattering gas, that by assuming a dust-cloud instead of a gascloud, a moderate mass will suffice to account for the observed extinction. In this case the absorption does not depend on colour. If a reddening of the stars is observed, indicating an absorption through scattering, we may still find a moderate mass, if the gascloud is mixed with dust particles. This would be in harmony with the views of ARRHENIUS, who has found in his studies on cosmogony that the small particles in space, driven away by lightpressure, are caught and collected in the extensive world nebulae.

Physics. — *"The so-called cyanogen-bands"*. By G. HOLST and E. OOSTERHUIS. (Communicated by Prof. H. KAMERLINGH ONNES).

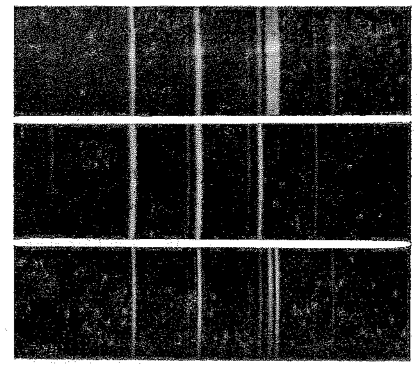
(Communicated at the meeting of May 29, 1920).

In photographing the nitrogen-spectrum one usually observes a number of bands, which were formerly ascribed to cyanogen [1]).

The most prominent of these bands lie between 3855 and 3883 Å. and between 4158 and 4216 Å. In 1914 GROTRIAN and RUNGE [2]) made some experiments, from which they concluded, that these bands are due to nitrogen and should not be ascribed to cyanogen. Many later observers [3]) have considered this view to be the right one.

We have made a new investigation on this point and came to the conclusion that these bands are not due to nitrogen, but to one of its compounds which condenses at a much higher temperature. In our experiment the discharge tube was a cylindrical glass tube with one electrode connected to a Tesla-transformator. The gas in the tube was an argon-nitrogen-mixture containing about 15 °/₀ of nitrogen. The gaspressure was about 55 cm. Under these circumstances the spectrum shows no argon lines, only the nitrogenbands and the so-called "cyanogen-bands". (Fig. 1).

A. *B.*



1.
2.
3.

The bands 3855—3883 Å can be seen at *A*, the bands 4158—4216 Å at *B*.

In order to discriminate whether these bands are due to nitrogen or to cyanogen, we immerged the lower half of the discharge tube into a glass filled with liquid oxygen and so obtained the spectrum fig. 2.

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[1]) See KAYSER, Handbuch der Spectroskopie. Bd. 5.

[2]) W. GROTRIAN and C. RUNGE. Phys. Z. S. 15, 545. 1914.

[3]) W. STEUBING. Phys. Z. S. 20, 512. 1919.
L. GREBE und A. BACHEM. Verh. D. Phys. Ges. 21, 454. 1919 and Zeitschr. f. Physik, 1, 51. 1920.

The so-called cyanogen-bands have completely disappeared; it follows that these bands do not belong to nitrogen, but to a much more easily condensable substance, probably cyanogen.[1])

This is in accordance with STEUBING's observations; the latter found no trace of the cyanogenbands in his experiments, where the presence of any carbon was excluded.[2])

Probably GROTRIAN and RUNGE's nitrogen was not completely free from carbon. This may be due to the fact that they purified their nitrogen by pyrogallicacid-solution; during this operation small quantities of carbon monoxide are usually developed.

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[1]) In some of our experiments we completely immersed the discharge-tube in liquid oxygen, the spectrogram being taken through the walls of the Dewarvessel. During the operation of the Tesla transformer the walls of the Dewarglass show the green fluorescence of cathode-rays. In one of our experiments however some gas was liberated in the space between the walls of the Dewarvessel, so that a red glow appeared, the radiation of which is superposed on that of the discharge-tube. The so-obtained spectrogram is shown in fig. 3. A peculiar phenomenon may be observed. Some of the cyanogen-bands, namely 3855, 3883 and 4168 Å. come out very strongly, whereas the other ones are absent. So it is not impossible. that the cyanogen-bands are due to two different carriers.

[2]) Simular results have been obtained by L. HAMBURGER, who also found no trace of the cyanogenbands in extremely pure nitrogen. Chem. Weekblad (15) 931 1918. (Added in translation).

Physics. — *"The geodesic precession: a consequence of* EINSTEIN'S *theory of gravitation."* By Dr. A. D. FOKKER. (Communicated by Prof. H. A. LORENTZ).

(Communicated at the meeting of October 30, 1920).

It is well known at present what parallel displacement or geodesic translation means in non-euclidean space[1]). And we know also that a compass rigid, moving parallel to itself and completing a closed circuit, in consequence of the curvature of space, will not regain the same orientation which it had before: a certain rotation of curvature will become apparent. Now it occurred to SCHOUTEN that the earth's axis of rotation — provided the earth were a sphere — should remain parallel to itself in the general geodesic sense during the motion of the earth round the sun. Thus, after a year, we must expect the earth's axis to point to a slightly different point of the heavens according to the curvature of space produced by the sun's gravitation. This affords an additional precession which superposes itself on the precessions due to other causes known in astronomy[2]).

The problem however is not so simple as it is put here. Though it can be proved that the axis of rotation will remain parallel to itself in the geodesic sense, yet in reality we have to consider the dragging of the earth's axis along her four-dimensional helicoidal track through time-space and not a circuital displacement in the ecliptic at some definite instant. The problem should be put as one of four-dimensional geometry; it is a problem of mechanics, and not a problem of three-dimensional geometry. If this be done properly, then the result is that we are to expect a precession one and a half times the precession foreseen by SCHOUTEN, viz. 0.019 of a second of arc per annum[3]). This will be shown in the present paper.

The idea at the bottom of the argument is the following. Imagine that in order to describe motions taking place in the neighbourhood of the earth's centre we choose axes such that the time is always

[1]) LEVI CIVITA, Rendic. Circ. Mat. Palermo, **42**, p. 1, 1917; SCHOUTEN, Direkte Analysis zur n. Relativitätstheorie, Verhandelingen Kon. Akad. v. Wetensch. Amsterdam, XII, no. 6, 1919; WEYL, Raum, Zeit, Materie, Berlin 1920, 3rd ed.; Cf. also an article of the present author in Proceedings Kon. Akad. v. Wetensch. Amsterdam, **21**, p. 505, 1918.

[2]) SCHOUTEN, Proceedings Kon. Akad. v. Wetensch. Amsterdam, **21**, p. 533, 1918; with appendix by DE SITTER.

[3]) Cf. also a paper by KRAMERS, Proc. Amsterdam, September 1920.