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but the figures of ovary and fruit: 10, 11 and 12 are quite similar to the specimens in the Utrecht museum, as indeed all the other figures. [Only the cilia at the top of the perianth leaves are figured somewhat shorter; this is, however, intelligible, as BECCARI had dried plants to work with and I had excellently preserved alcoholic material at my disposal.

My conclusion is therefore that the plants found in Tjionas belong to *Sciaphila corniculata* BECCARI and that the distribution of this species is consequently not limited to New-Guinea, as BECCARI had imagined.

If we may now assume that the figures of *S. nana* given by BLUME are not very accurate — an assumption which does not seem to me to be very hazardous —, and if we further eliminate from BLUME's description the unbranched shoot, which was probably due to an accidental property of the specimen described, then it seems to me, that we may well assume, that *S. nana* of BLUME and *S. corniculata* of BECCARI are names for one and the same species, especially as so far no other species of this genus have become known from Java except the so widely different *S. tenella* BL.

There is however no complete certainty on this point, and as long as this is not the case, it will be best to affix the name of the accurately described *Sciaphila corniculata* BECCARI to the specimen in question, and for the present to regard the name of *Sciaphila nana* BL. as not sufficiently well characterized. Possibly a future monographer, having many more data at his disposal, will be able to restore this name, but at present it is better to reject it.

Utrecht, December 1908.

Astronomy. — "*The Solar Vortices of HALE*". By MR. A. BRESTER Jz.
Communicated by Prof. W. H. JULIUS.

On the more or less cyclonic configuration of the hydrogen flocculi around the spots on the spectroheliographs of the solar atmosphere and on the shifting and the becoming invisible of one of these flocculi at a short distance from a spot, HALE recently founded the hypothesis that the spots are vortices, which from the solar atmosphere continually absorb the hydrogen, which there comes back every time as new protuberances or flocculi outside the spots.¹⁾

¹⁾ HALE: *Astroph. Journ.* Sept. 1908 — Contrib. from the Mt. Wilson Sol. Obs. No. 26.

At the outset I think I ought to observe that this hypothesis, which is considered by HALE himself, with the laudable caution characteristic of him, as still very uncertain ¹⁾, is in a hardly explicable contradiction with the equality of the angular velocity of the hydrogen-floculi in every latitude, which HALE has made probable in an earlier investigation ²⁾.

For if, between these floculi and the spots there is the connection that HALE supposes, we should not expect the same angular velocity, at each latitude, but rather very different angular velocities, which would have to answer to the great aequatorial acceleration of the spots.

But the hypothesis that the spots are absorbing vortices, has often been proposed, but has always turned out very improbable. For a vortex leads us to expect first of all that it rotates. But generally nothing is seen of this rotation in the spots. CARRINGTON, SECCHI and YOUNG have more than once intentionally set this forth. According to these observers some indication of a cyclonic configuration is shown in only 2 or 3 per cent of the spots, and this configuration is most times such that it would prove a rotation in opposite direction in different parts of a same spot and consequently an impossible rotation for the whole spot. ³⁾ Moreover MITCHELL ⁴⁾ as well as HALE and ADAMS, ⁵⁾ in their investigations of the spot-spectrum, have found the gaseous substance of the spots generally in almost perfect rest. Besides the spots, as a rule, do not seem to be concave, but convex. ⁶⁾

Although these clear facts, which have been known a long time already, make it very improbable that the spots are to be considered as absorbing vortices, in HALE's paper on "Solar Vortices" this improbability is demonstrated also in other ways. If there were in reality absorbing vortices above the spots, it would be impossible

1) HALE: Contrib. 26 p. 14.

2) HALE: Astroph. Journ. April 1908.

3) YOUNG: The Sun 1895 p. 126 — SECCHI: Le Soleil I. p. 89.

4) MITCHELL: Astroph. Journ. 22 p. 38.

5) HALE und ADAMS: Astroph. Journ. 25 p. 87.

6) Already at the first discovery of the spots CHRISTOPHORUS SCHEINER drew the attention to their often occurring convexity and to their origin as through the bursting of bubbles. (Rosa Ursina 1626—1630 p. 461, 493, 513 etc.). See further: HOWLETT: M. N. Dec. 94 — Sidgreaves M. N. March. 95 — WILSON: M. N. 55 p. 458 — FROST: Astr. a. Astroph. II. p. 734 — MAUNDER: Journ. Br. Astr. Ass. 17 p. 128 — CORTIE: Astroph. Journ. 7 p. 248 — MOREUX: Bull. Soc. Astr. de France Janv. 1907.

of course that their absorbing action would only be shown by a single one among the many flocculi which HALE saw floating above the spot studied by him. Yet we should have to believe in that impossibility, for among all the other flocculi above the spot HALE could not observe one, not even among the smallest and nearest to the spot, that showed the slightest advance towards the spot ¹⁾.

In my opinion it is not at all certain even that this single dark flocculus, which HALE thought sufficient to prove the absorbing action of the Solar Vortices, actually disappeared in a spot. It is also quite possible that this flocculus, amidst other incessantly renewing and shifting flocculi, has been covered up by them in consequence of which it has become invisible. On very close and unprejudiced inspection, to be sure, we see that much of the quasi-absorbed flocculus is left on the clichés obtained after the supposed absorption.

But even more clearly than by the hydrogen flocculi the non-existence of material vortices is proved by the imperturbable rest of the calcium flocculi, which never show the least trace of a cyclonic configuration ²⁾, although according to HALE and also as appears from their angular velocity ³⁾, which FOX found to be somewhat smaller, they are probably even a little nearer to the spots than the hydrogen flocculi.

So it is on account of all these old and new direct evidences that I have come to the conviction that the spots are no material vortices. Neither the spectroheliographs of HALE, nor his discovery that there are lines in the spectrum of the spots, which most probably show the ZEEEMAN effect ⁴⁾, have been able to indirectly weaken my conviction.

So, if, according to me the spots are no material vortices, but when the cyclonic configuration of the hydrogen-flocculi still reminds us in some degree of such vortices (vortices to be sure, according to HALE "so complex", I should prefer to say "so impossible" that, not unfrequently they show opposed motions in neighbouring places) ⁵⁾ we have now to explain how, also without material vortices, such a quasi-cyclonic configuration can originate.

A few years ago already I showed a way to come to that expla-

¹⁾ HALE: Contrib. 26 p. 15.

²⁾ HALE: Astroph. Journ. April 1908. — FOX: Astroph. Journ. Sept. 1908.

³⁾ HALE. Contrib. 26 p. 1, 6; Plate XXXVI.

⁴⁾ Nature, Aug. 20 1908.

⁵⁾ HALE: Contrib. 26 p. 6 "Although most of the points in a given region appear to move together, there are a sufficient number of apparently opposed motions to weaken seriously the value of the evidence".

nation, when I pointed out as follows how the Polar Auroras originate on the earth through the spots on the sun. ¹⁾ If we want to follow this explanation, we must suppose that there are radioactive substances on the sun. This supposition is surely not in the least extravagant, since we know how generally such substances are found on the earth and also take in consideration, how as a rule the same substances which we know on the earth, are also found on the sun. Moreover it is probable, also according to RUTHERFORD, that on the sun the radioactivity of matter will show itself even more energetically than on the earth, which is so much cooler. ²⁾ If now there are radioactive substances on the sun — and also the presence of Helium is in favour of this — such substances will remain hidden under the photospherical shell, owing to their great weight, just as all other elements of great weight. So, under this shell their α , β and γ rays will originate. But for the greater part these rays will be prevented by this comparatively thick shell from escaping from the sun. Only where there are holes in this photospherical shell and so especially where we see spots, this impediment will not be so great. And so, out of each spot just as out of the leaden vessel in the investigations of Mrs. CURIE a bundle of more or less parallel β and γ rays will come forth, vertically going out into the wide world. If now such a bundle, which is often many times thicker than the earth, comes in contact with our atmosphere, it will bring here about all these electric and luminescence phenomena which have already been considered by BIRKELAND, PAULSEN and ARRHENIUS ¹ as caused by kathode rays of the sun and ² as the cause of our Polar Auroras and of our magnetic disturbances. ³⁾

If, by means of these supposed strong bundles of rays there is such a simple connection between these earthly phenomena and the cavities of the solar spots, we understand at once:

1. why these earthly phenomena have the same period of 11 years as the spots;
2. why also every year these earthly phenomena show maxima

¹⁾ De Nieuwe Courant 19 Febr. 1907 — Bull. Soc. Astr. de France Juin. 1907 p. 283 — Essai d'une Explication du Mécanisme de la Périodicité dans le Soleil et les Etoiles rouges variables. Verh. Kon. Akademie van Wetenschappen te Amsterdam IX. 6 p. 19—21 (1908).

²⁾ RUTHERFORD: Radioactivity 1904 p. 344 — MAUNDER: Knowledge Nov. 1903 p. 255.

³⁾ ARRHENIUS: Lehrb. d. Kosm. Physik. p. 152 — PAULSEN: Bull. Soc. Belge d'Astr. Oct. 1906 p. 381. See also my Essai of 1908 p. 20—23 referred to above,

in March and September and minima in June and December. (For the axis of the sun is in such a direction that in March and September those bundles of rays which are surest to reach us, are most numerous because then they are emitted from the parallels of $7\frac{1}{4}^\circ$ respectively southern and northern latitude, which are comparatively rich in spots, while such bundles occur most rarely in June and December, because then they must proceed from the equator which has very few spots).

3. why these earthly phenomena also have a period of 27 days which agree with the synodical rotation of the spots, and

4. why also these earthly phenomena often become more powerful suddenly, when a great spot appears on the sun.

My hypothesis that Polar auroras will originate here when bundles of β and γ rays thrown out by the solar spots reach our atmosphere, is considerably strengthened by the important fact discovered by Sir and Lady HUGGINS, that when also here in our laboratories the rays of Radium come in contact with our atmosphere, they cause in it a luminescence, which spectroscopically show the same four nitrogen lines, which have also been found among the most important of the Polar Aurora by PAULSEN ¹⁾.

Though the Polar Aurora shows many distinct phenomena, which agree very well with my explanation of its origin, it also shows many other phenomena, which, although very mysterious still, are also of the highest importance for the theory of the sun. Such mysterious phenomena are the rapid motions which the light configurations of the Polar Auroras so often show. What it is that in the Polar Auroras causes their bows to wave, their curtains to fly, their brilliant sea of flames to trill, their bundles of rays to flash out suddenly, we do not know. But we do know (and that is the thing really of the greatest importance for the theory of the sun) that all these rapid motions cannot be ascribed to material changes of place. In the time of VON HUMBOLDT, who tells it to us ²⁾, the inhabitants of the Shetland Islands may have considered such motions as caused by a "merry dance in Heaven"; the astronomers may still go on taking rapidly appearing rays on the sun for "terrible eruptions", here on our calm earth such fantastic speculations are

¹⁾ Sir W. HUGGINS a. Lady HUGGINS.: *Astroph Journ.* Sept. 1903. On the spectrum of the spontaneous luminous Radiation of Radium at ordinary temperatures. — The four nitrogen lines photographed in this investigation and found among the most important of the Polar Aurora by PAULSEN are the lines 3372, 3575, 3918 and 4285. ARRHENIUS: *loc. cit.* p. 910.

²⁾ v. HUMBOLDT: *Kosmos* 1st vol. 2nd part p. 200.

too naive. For us it is impossible to see material eruptions in the bundles of the auroral rays which often shoot up as quick as lightning. In all such sudden shiftings of light the molecules of our atmosphere remain comparatively at rest and probably it is only electrons or ions that move.

But if our Polar Auroras are such movable electric configurations, which originate when bundles of β and γ rays, sent out by the solar spots, come in contact with our atmosphere, then it is quite conceivable that analogous movable configurations will originate also in the solar atmosphere itself around the spots, if there these same bundles, just escaped from the spots and consequently much more powerful even than here, pass through the solar atmosphere. Thus the Protuberances of the sun and the rays of its Corona would have the same cause as the Polar Auroras of the earth and the "Solar Vortices" of HALE would be "Solar Auroræ". In all these phenomena only ions would move, and, as I have already maintained these 20 years ¹⁾, the matter would remain at rest.

For that identical origin of on the one side the Protuberances and the Corona of the sun and on the other side the Polar Auroras on the Earth, which identical origin I have already discussed in my last Essai ²⁾, pleads also the remarkable agreement, which STASSANO

¹⁾ As the fundamental principle of my theory of the sun I have always demonstrated the impossibility of the dogma of the solar eruptions. That demonstration will be found and will be seen to become more and more powerful in the following papers: Verklaring van de veranderlijkheid der 100de sterren p. 9—11. (Mei 1888) — Essai d'une Théorie du Soleil et des étoiles rouges variables p. 20 (Dec. 1888) — Théorie du Soleil. Verhandelingen Kon. Akad. v. Wetensch. te Amsterdam I. No. 3. p. 1—30 (1892) — Astron. a. Astrophysics Dec. 1903, March 1894 p. 218, Dec. 1894 p. 849. — My last Essai of 1908 referred to above p. 1—31. Het 17de Jaarverslag van het Technologisch Gezelschap te Delft, p. 87—124, Een theorie van de zon.

²⁾ Essai d'une Explication du Mécanisme de la périodicité etc. 1908 p. 20—23, 84, 125. In this my last Essai I have shown on p. 21, that, if the solar spots throw out the bundles of rays which I suppose, it is very clear why the same period of 11 years of the solar spots is also observed in the 3 following luminescence-phenomena; 1. in the protuberances and the corona of the sun, 2. in the Polar Auroras on the earth and 3. in the Comets. Thus it appeared in the investigations of BERBERICH that during the maximum period of the spots (so, when the Comets have the greatest chance of being brought to greater luminescence by the bundles of rays meant by me) the radiance of the Comet of ENCKE is greatest and that then also the discovery of very small Comets is most successful. (Astron. Nachr. n°. 2836 and 2837). The sudden variations of light, which the Comets sometimes show and which now have been seen again so distinctly in the Comet of MOREHOUSE, may also be explained perhaps by their temporary contact with the bundles of rays thrown out by the solar spots. On the same page 21 of my

discovered in the spectra of these three sources of light. STASSANO has found, that while $\frac{2}{3}$ of the lines in the spectrum of the Polar Aurora must be ascribed to Neon, Argon, Krypton and Xenon, also the light of the Protuberances and especially of the Corona greatly emanates from the same newly discovered elements of the Zero-group. Among the spectral lines, which have been found in the Protuberances by DESLANDRES and HALE, there are, according to STASSANO, 44 which belong to this Zero-group and nearly all the 339 corona lines, photographed by HUMPHREYS during the eclipse of 1901, are also lines of this group. ¹⁾ And so it is the same elements which (according to me also for the same reason) cause the same light to shine on the outside of the sun and the earth.

If there is therefore great reason to take HALE's "Solar Vortices" for Solar Aurorae, the configurations and the motions of the hydrogen-floculi in these Vortices do not at all clash with the improbability of the existence of material vortices.

For these floculi then agree with the electric light configurations of our Polar Auroras and like these they will move without any change in the place of the molecular matter.

HALE's Solar Vortices instead of weakening my idea about the rest of the sun, give on the contrary unexpectedly a splendid support to this idea. For they help to remove the principal objection, which has always wrongly been raised against this idea and has been derived from the shifting of the spectral lines. For if, for the many reasons developed above, we consider these Vortices as Aurorae, they lead us to the conclusion that, although a gas is at rest, yet it will show shifted spectral lines, if only it contains enough ions rapidly moving in the line of sight. The correctness of this conclusion, at which, on other grounds also SCHUSTER has lately arrived, ²⁾ was a few years ago experimentally proved by STARK, when, in examining the light of hydrogen in the

Essai is also illustrated the characteristic change of shape of the corona with the period, and the rays of the corona are not taken for real eruptions (as SCHAEERLE does), but for luminescences, analogous to the rays of the Polar Aurora. In my Essai (p. 84—88) has also been treated the repartition of the Protuberances, little agreeing with the repartition of visible spots. Openings, too small to be seen as spots throw out nevertheless their bundles of rays which form their Protuberances. If now these openings, as my theory tries to demonstrate, are smallest at a latitude from 60 to 65°, then with that the constant minimum of the Protuberances at this latitude is explained too.

¹⁾ ARRHENIUS: Lehrb. d. Kosm. Physik. p. 911.

²⁾ SCHUSTER: Nature 29 Oct. 1908.

direction of channel rays which he led through it, he photographed at the same time 1. the normal lines of the hydrogen at rest and 2. the strongly shifted lines of the hydrogen-ions in motion. ¹⁾

And so finally it appears that the relative tranquillity of the sun, never disturbed by terrible eruptions, as has been proved so clearly by numerous important solar phenomena and has been demonstrated especially also in the last year by the rotation-investigations of ADAMS, HALE and FOX, ²⁾ is not even in contradiction with a DOPPLER shifting of the spectral lines of the Protuberances.

Delft, the 1st of January, 1909.

Physics. — “On the course of the isobars of binary mixtures.”

By Prof. PH. KOHNSTAMM. Communicated by Prof. J. D. VAN DER WAALS.

1. In these Proceedings of June 27th 1908 VAN DER WAALS showed that only if $a^2_{12} < a_1 a_2$ the curves $\frac{dp}{dx} = 0$ and $\frac{dp}{dv} = 0$ can touch for volumes larger than $3b$, the critical volume of the mixture taken as homogeneous. On the supposition $a_1 a_2 = a^2_{12}$ the point of contact lies at a value $v = b$. Now at higher temperature the well-known diagram of isobars (These Proc. IX p. 630) leads to the intersection of the two branches of $\frac{dp}{dv} = 0$ on the line $\frac{d^2p}{dv dx} = 0$, which takes place at the minimum critical temperature of the system under discussion. Then the line $\frac{dp}{dv} = 0$ divides into two branches, which we can now denote as the lefthand branch and the righthand branch. The lefthand branch necessarily intersects the line $\frac{dp}{dx} = 0$ in two points, and as it contracts more and more, while the line $\frac{dp}{dx} = 0$ moves towards the right with increase of temperature — the asymptote of this locus being given by $\frac{da}{dx} = MRT \frac{db}{dx}$ — contact must take place, and that for a volume larger than that for which the line

¹⁾ STARK: *Astroph. Journ.* Dec. 1906, p. 362.

²⁾ ADAMS: *Astroph. J.* November 1907, April 1908. — HALE: *ibid.* April 1908. — FOX: *ibid.* Sept. 1908.