

# The tortuous discovery of the Gegenschein, false zodiacal light & zodiacal band – Brorsen vs Jones

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It is routinely thought that Brorsen discovered the Gegenschein and zodiacal band in 1854. Here, it is argued that priority for the Gegenschein should go to Jones. Both also observed the false zodiacal light, which von Humboldt had seen long before. As that was not recognised as a separate phenomenon until c. 1950, Brorsen imagined it to be a part of the Gegenschein and Jones of the band, thus causing much confusion in concepts and nomenclature.

## The Gegenschein

The Gegenschein (German for ‘countershine’) is a diffuse glow in the night sky caused by the backscattering of sunlight off interplanetary dust outside Earth’s orbit. Situated exactly at the antisolar point (ASP) in the ecliptic, it is effectively a ghostly mirror image of the Sun or ‘antisun’ that changes its position with the Sun’s invisible passage below the horizon. Best seen around midnight, when it appears highest in the sky, in months when it is not in front of the Milky Way,<sup>1</sup> it varies in shape from ‘small and somewhat elongated’ to ‘very large and round’.<sup>2</sup>

The Danish astronomer Theodor Johan Christian Ambders Brorsen (1819–1895) is best known for his discovery of no less than five comets in the period 1846–1851, but in a recent article Donald Olson also identified him as the first person to have described the Gegenschein – in 1854,<sup>3</sup> with the first sighting dated to April 17 of that year.<sup>4</sup> Earlier, Fechtig *et al.* (2001),<sup>5</sup> Roosen (1971) and others had reached the same conclusion.<sup>6</sup> Olson laid to rest the occasional claim that the French savant Esprit Pezenas (1692–1776) had made an earlier observation of the phenomenon on 1730 February 15, as that doubtless concerned a type of auroral arc. However, George Jones (1800–1870) arguably observed the Gegenschein a couple of months before Brorsen did so.

Jones was an American Navy chaplain, whose pioneering studies on the zodiacal light are well known. His monumental report of observations made in 1853–1855 on board the steam frigate *Mississippi*, published in 1856, made an invaluable contribution to the field, despite its erroneous contention that the zodiacal dust cloud is centred on Earth. In later articles integrating additional work in the Ecuadorian Andes, Jones reflected that he had looked in vain on that occasion for Brorsen’s Gegenschein.<sup>7</sup> It does not seem to have occurred to him that he may have spotted it unknowingly during his earlier journey, as borne out by two passages in his monograph. For the morning of 1854 January 30,

while travelling at 26° 10’ N, Jones had written that he was at a loss to account for a feature in the night sky:

‘There is a broad streak of sky from Regulus up to the Milky Way ..., which puzzles me. I cannot make out whether its peculiar appearance is owing to the Zodiacal Light, or to a want of stars and a steady paleness or dimness there. From Præsepe up, however, it seems to amount almost or quite to a positive light, like the Diffuse Zodiacal Light. At 3<sup>h</sup>, 4<sup>h</sup>, and 5<sup>h</sup>, however, I could not see it higher than nearly to Regulus. But these palenesses are all so indefinite, that it is often difficult to get their boundaries ...’<sup>8</sup>

The observation was made between 2 and 5 a.m., while the sky was ‘very clear’. About two weeks later, on the evening of February 15, Jones was at 35° 19’ N and commented on what must be the same mysterious glow:

‘There is a regular paleness of the sky from Regulus, up by Præsepe, &c., to the Milky Way, and about 8° wide; its centre nearly or quite on the ecliptic. It amounts almost, if not quite, to a positive light, and seems like a dim branch of the Milky Way, that has strayed off from the general course.’<sup>9</sup>

In 1932, Cuno Hoffmeister noted that this passage describes the Gegenschein ‘quite accurately’: ‘The centre of the Gegenschein should be located slightly east of Regulus.’ Hoffmeister added the zodiacal band (see p.7) as a possible referent, but with a caveat: ‘Because the observation took place in the evening towards 7 o’clock, the luminous band could not be seen further to the east.’<sup>10</sup> Nothing in Jones’ wording warrants a role for the zodiacal band, but the timing of around 7 p.m. can be confidently inferred from the fact that the Moon rose soon after and Jones turned his attention away from the zodiacal light in the west to the eastern



**Figure 1.** Theodor Borson (1819–1895). Gave the oldest known description of the zodiacal band (unwittingly), as seen by him on 1854 April 16. (*Nordborg Lokalhistoriske Arkiv*)



**Figure 2.** George Jones (1800–1870). Gave the oldest known description of the Gegenschein, as seen by him on 1854 January 30 and February 15. (*Naval History and Heritage Command*)

horizon in order to ‘catch the first appearance of the moon’s Zodiacal Light’. While the latter notion has long been discredited, the Gegenschein would then be in that part of the sky, some distance above the horizon, and could only be seen in the Moon’s absence. An appearance around 7 p.m. is early indeed for the Gegenschein, but the location of the ‘paleness’ relative to the stars was identical to that in the early morning hours of January 30 and Jones did state that it ‘was a very fine evening’, with the ‘sky remarkably clear and good’. The two reports of the ‘paleness’ contain enough detail to be confident that Hoffmeister’s main assessment is spot on. Jones’ size estimate of the spot, too, is realistic for the Gegenschein. This would make these reports the earliest known scientific descriptions of the Gegenschein, even if Jones was unaware that he had recorded a novel phenomenon.

## The false zodiacal light

The matter is compounded by a confusion of terminology. Olson makes it look as if Borson used the word Gegenschein exclusively in the modern sense, but this is not quite the case. Certainly, Olson cites Borson correctly as locating the brightest part of what he called the Gegenschein at the antisolar point, but what was Borson contrasting this brightest part with? To be sure, others have reported that a fainter glow that can be elongated may surround a brighter core in the Gegenschein.<sup>11</sup> In Borson’s case,

however, the fainter part looked like an exact pyramidal mirror image of the true zodiacal light rising over the opposite horizon. Having first observed it on 1854 March 18 around 9.30 p.m., he saw its outline more distinctly between 9 and 10 p.m. on 1854 April 14 & 15 – a few days before he discerned the ‘bright part’ – and later again on 1857 April 17 and at an unspecified time on 1857 October 24.

Borson plausibly compared this ‘countercone’ to a feature that Alexander von Humboldt (1769–1859) had noted on 1803 March 16–18, while travelling off the Pacific coast of Central America at 13–15° N, and had called a ‘Gegenschein’ in contrast not to the Sun, but to the cone of true zodiacal light.<sup>12</sup> Olson recognised Borson’s reliance on von Humboldt for the term, but did not make it clear that Borson saw something very similar to what von Humboldt had reported. It transpires that Borson initially adopted the term Gegenschein purely in that sense, and subsequently, upon viewing the comparatively brighter antisun, extended its meaning to include that. Borson dismissed von Humboldt’s hunch that the countercone was a reflection of the main cone of zodiacal light, linking it instead to the antisun.

In 1946–1950, Russian scientists Nikolai Borisovich Divari (1921–1993) and Vasiliy Grigorevich Feskov (1889–1972) discovered the so-called ‘false zodiacal light’,<sup>13</sup> now known to be produced by atmospheric backscattering. This is theoretically superimposed on the Gegenschein when that is close to the horizon, but unlike that is entirely atmospheric.<sup>14</sup> Roosen realised that the false zodiacal light is what von Humboldt must have seen and

intuitively understood.<sup>15</sup> It surely corresponds to the ‘fainter part’ of Brorsen’s Gegenschein as well.

In hindsight, Brorsen saw both the false zodiacal light and the Gegenschein, but erred in lumping them together. It has apparently eluded everyone until now that it was this conflation – understandable for the time – that resulted in the inadvertent shift in meaning of the term Gegenschein. While the Gegenschein is relatively well known, the false zodiacal light has rarely attracted attention in recent decades.

## The zodiacal band

The zodiacal band adds to the tangle. Fainter still than the Gegenschein, this is sunlight directly reflected off interplanetary dust outside Earth’s orbit.<sup>16</sup> It is perceived as a narrow strip of white light extending along the ecliptic from one of the cones of zodiacal light, sometimes all the way to an opposing cone of true or false zodiacal light. Brorsen does emerge as the first to have documented this glow. His observations of an extension (*Fortsetzung* and *Verlängerung*) of the zodiacal light pyramid along the ecliptic, beginning on the evening of 1853 December 3,<sup>17</sup> were followed on the evening of 1854 April 16 by his first perception of a complete arch that he called a ‘light bridge’ (*Lichtbrücke*).<sup>18</sup>

Jones, too, saw the band, but at a later time, starting on 1856 October 7.<sup>19</sup> In 1853 July and August, while at latitudes between 33° N and 21° N, he had made some observations of an unexpected ‘eastern light’, mainly between 8.30 and 10.30 p.m., that he had been wary to identify as the zodiacal light proper.<sup>20</sup> In notes appended to these diary entries in 1856, he had nevertheless surmised it to be some sort of reflection from the Sun and linked it with the Gegenschein reported by von Humboldt and Brorsen.<sup>21</sup> Once he had seen the band for himself, Jones retrospectively related it to these earlier observations of his, in a bid to establish priority over Brorsen.<sup>22</sup> However, these earlier observations must again have concerned the phenomenon now called the false zodiacal light,<sup>23</sup> even though Jones denied having seen the fainter pyramidal part as well as the bright part of the Gegenschein as mentioned in Brorsen’s reports.<sup>24</sup>

The confusing result was that Jones used the term Gegenschein even more broadly than Brorsen had done, including also the zodiacal band and what Brorsen had described as an extension of the zodiacal light cone.<sup>25</sup> At the same time, Jones distinguished this expansive Gegenschein from a second cone of true zodiacal light above the horizon that he had repeatedly been able to observe simultaneously with the first under exceptionally favourable circumstances, when the ecliptic appeared almost perpendicular to the horizon at both ends around midnight.<sup>26</sup> Thus:

‘The gegenschein has always appeared to me as a white light, exactly resembling that of the milky way, and with parallel borders, except at its lower extremity, where it mixes with the glare of the horizon, and seems to spread a little. At midnight, the light is all gegenschein, except at the two extremities on the horizon ... in the deep hours of the night, when the sun was now acting at both horizons so as to make the *zodiacal light proper* overpower the gegenschein, there was then a small pyramid of yellowish light at each horizon.’<sup>27</sup>

There is irony in the fact that Jones would have himself be the first to see the zodiacal band and Brorsen to see the antisun, while

the reverse would now appear to be true. In summary, using the modern definitions:

Date(s)	Authority	Observed
1730 Feb 15	Pezenas	Auroral arc
<b>1803 Mar 16–18</b>	<b>von Humboldt</b>	<b>False zodiacal light (oldest record)</b>
1853 July–August	Jones	False zodiacal light
1853 Dec 3 –	Brorsen	Extended zodiacal light cone
<b>1854 Jan 30</b>	<b>Jones</b>	<b>Gegenschein (oldest record)</b>
<b>1854 Feb 15</b>	<b>"</b>	<b>"</b>
1854 Mar 18 –	Brorsen	False zodiacal light
<b>1854 Apr 16 –</b>	<b>Brorsen</b>	<b>Zodiacal band (oldest record)</b>
1854 Apr 17 –	Brorsen	Gegenschein
1856 Oct 7 –	Jones	Zodiacal band

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