On the Norway Spirals and their Physically Impossible "Ripple" Propagation

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Abstract:

On the morning of December 9th, reports of strange, spinning spirals flooded the internet and media outlets. They have come to be known as the "Norway Spirals". Though popularly attributed to a 3rd stage failure of a Russian "RSM-56 Bulava" Submarine Launched Ballistic Missile (SLBM), it can be shown with some basic trigonometry that this explanation is physically impossible. From a single, time-lapsed photo and anyone of the many videos of the spirals, the speed at which the "ripples" caused by the phenomena propagate can be calculated at two limits:

1) In the lower limit, the spiral is taken to be directly over the mountain in the photograph (16.91 km away) and the velocity of the "ripple" propagation is approximately 316.8m/s.
2) In the upper limit, the spiral is taken to be directly over the White Sea (911.22km) and the velocity of the "ripple" propagation is found to be approximately 17,074m/s

It is assumed that the missile, the alleged cause of the spirals, would be somewhere roughly between these two points at the moment of the malfunction, yet these velocities suggest that the observed "ripples" cannot be particulate and therefore the spiral could not be caused by a missile.

1. Introduction:

Let us first examine a photograph (similar to many others available) of the spirals in question.

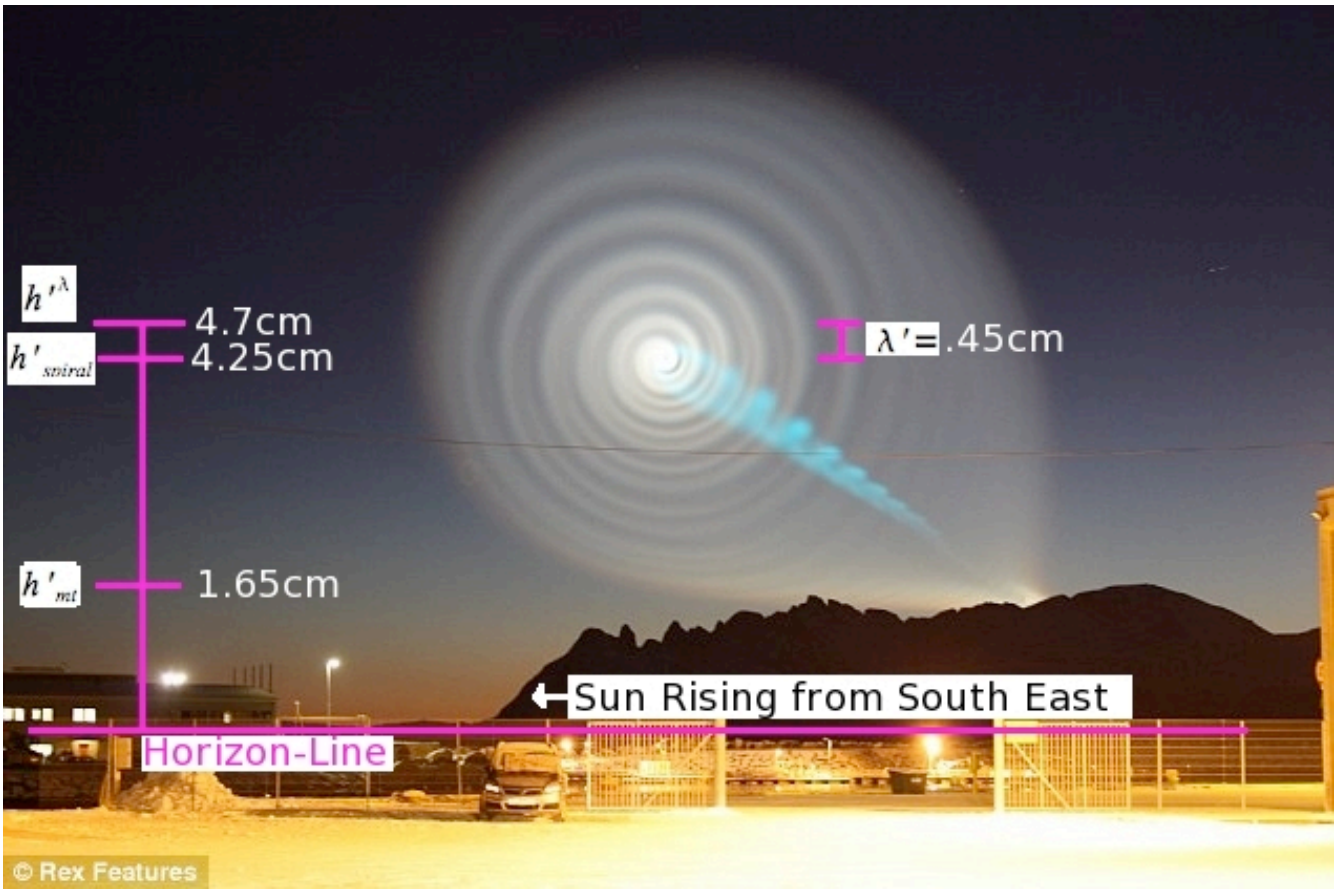

PHOTO 1

[http://www.dailymail.co.uk/news/worldnews/article-1234430/Mystery-spiral-blue-light-display-hovers-Norway.html}

This photograph was taken from Skjervøy, Norway near dawn on December 9th, 2009. We can clearly see two spirals. The white spiral appears to be in the plane of the picture and the blue spiral extends out of the picture-plane, but is not quite perpendicular to the plane. From here on, let us use simply the term "spiral" when referring to the *white spiral*.

Since it was very dark at the time, PHOTO 1 was captured using a long exposure time. The fact that the "ripples" in the spirals are so clear tells us that they were created from a sources with a near regular frequency of rotation. From watching the several videos available on the internet, we can see the "ripples" moving away from the spiral's center and we can find that the frequency (how many times the spiral rotates per second), f , is about 1Hz.

$$f = 1\,\mathrm{Hz}$$

Note, from here on:

-Prime variables $\{h', d', \lambda'\}$ will denote values measured from PHOTO 1.

-Non-prime variables $\{h, d, \lambda\}$ will denote values in the physical world.

From the Horizon-Line in PHOTO 1, we measure the distance to the center of the spiral (h'_{spiral}) , and top of the mountain (h'_{mt}) , the height of the 1st full wavelength, (h'^{λ}) , and the wavelength $(h'^{\lambda} - h'_{spiral} = \lambda')$

$$h'_{spiral} = 4.25\,\text{cm} \qquad h'^{\lambda} = 4.7\text{cm}$$
$$h'_{mt} = 1.65\,\text{cm} \qquad \lambda' = .45\text{cm}$$

[1]

Building on an insight that Kevin Martin shared at [http://www.youtube.com/watch?v=1GSa2wRtZRI], we look to Google Maps for information regarding this mountain. Investigating the terrain to the South-East of Skjervøy we find the mountain in PHOTO 1.

FIG. 1

FIG. 2

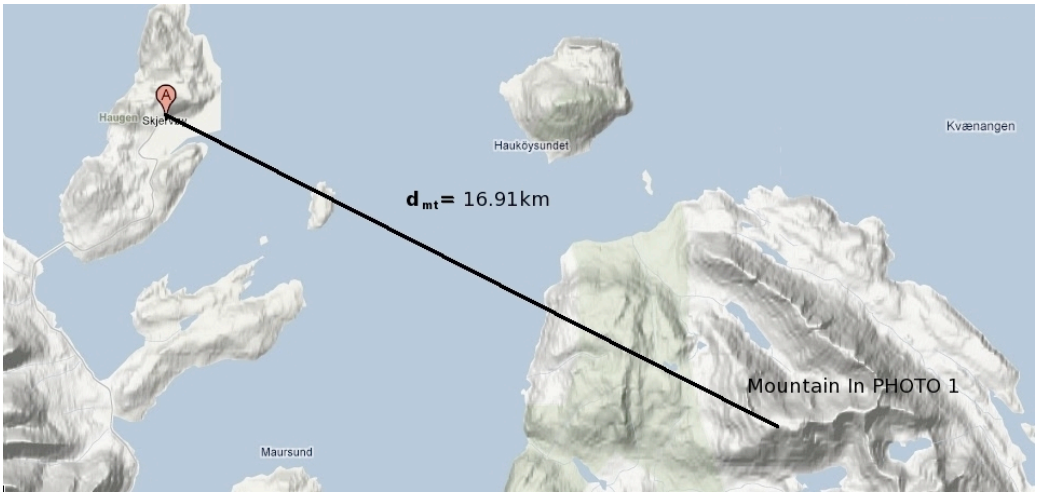

FIG. 3

1 Note that it is not important for my measurements from the picture to be invariant under scaling, rather, it is the *ratios* of these measurements that are of concern and which *are* constant.

Using Google Earth, we find the distance, from the center of Skjervøy to the center of the White Sea (d_{ws}) and to the peak of the relevant mountain (d_{mt}) - along with the mountain's peak height (h_{mt}) ,

$$d_{ws} = 911.22\text{km}$$
$$d_{mt} = 16.91\text{km}$$
$$h_{mt} = 1.162\ \text{km}$$

Notice how this peak lies almost perfectly in between the rising Sun and the town of Skjervøy- this agrees very well with PHOTO 1.

2. Analysis:

Ultimately, we want an expression for the wavelength of the spiral, which must depend on how far away the spiral is in reality.

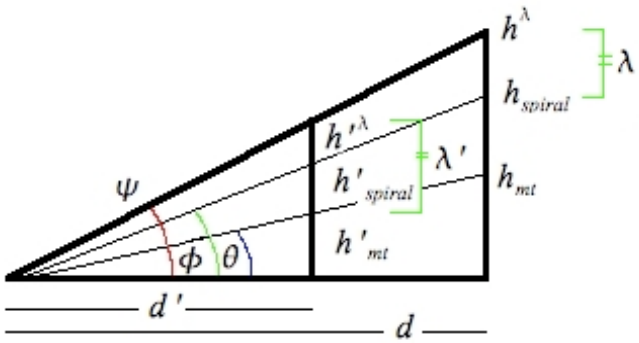

FIG. 4

Because the two triangles share the same angles, we can use the *Law of Similar Triangles* to equate ratios of similar length [2]. We now can use some basic trigonometry to calculate the angle between the Horizon-Line and the peak of the mountain:

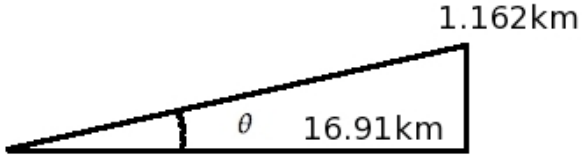

FIG. 5

$$\theta = \tan^{-1}\left\{\frac{1.162\text{km}}{16.91\text{km}}\right\} = 3.931^\circ \quad \ldots[1]$$

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2. Note:
For two similar triangles, as in *fig. a*,

$\frac{C}{A} = \frac{D}{B}$ *(they must share the same angle).*

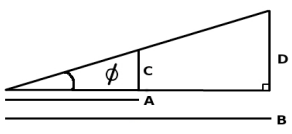


fig. a

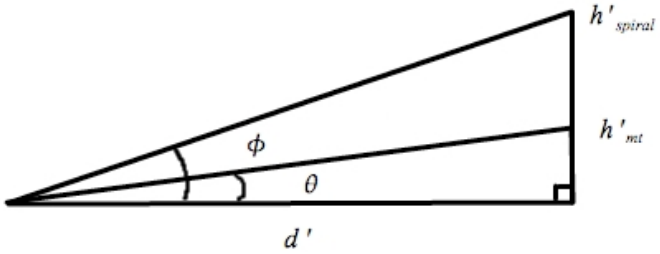


FIG. 6

Now we can solve for the distance to the mountain in the scale of PHOTO 1,

$$d' = \frac{h'_{mt}}{|\tan(\theta)|} = 24.01\text{cm} \quad \ldots[2]$$

What this means physically is that if we were to make a mockup of a tiny, toy photographer taking a picture of the mountain and spiral (like a diorama), and we wanted the distances involved to be to scale, we would make the mountain peak be 1.65cm tall, and put the mountain 24.01cm away from our little photographer. Further more, we would place the center of the white spiral 4.25cm above the ground.

With d', we can find the value for ϕ, the angle between the Horizon-Line and the center of the spiral.

$$\phi = 10.037^\circ \quad \ldots[3] \ .$$

3. Determining λ :

The wavelength (λ) is the difference between the top of the 1st wavelength and the height of the spiral's center. To find λ, we once again invoke the *Law of Similar Triangles* to relate h^λ and h'^λ.

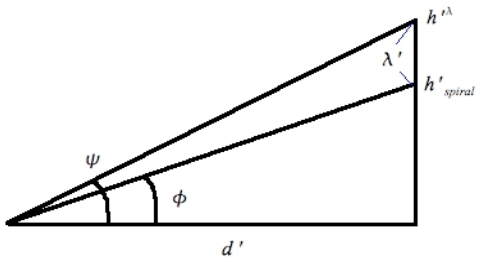


FIG. 7

$$h'_{spiral} = 4.25\,\text{cm}, \quad h'^{\lambda} = 4.7\,\text{cm}$$

Recall:

$$\lambda' = .45\,\text{cm}, \quad d' = 24.01\text{cm}$$

& Note: $\lambda = h^\lambda - h_{spiral} \quad \ldots[4]$

Comparing the lengths of the similar triangles sharing the angle ψ , we find the relation, from *FIG. 7*,

$$\frac{h^{\lambda}}{h_{spiral}} = \frac{4.7\text{cm}}{4.25\text{cm}} \quad \ldots[5]$$

Because we do not know how high up the white spiral actually is, this relation cannot give us any meaningful results by itself- this is why we will explore the limits of our situation.

4. LIMITS:

It is impossible from the data available to surmise exactly how far away the white spiral is in reality. But we can take limits and find some interesting results nonetheless. We will assume that the center of the white spiral is no closer than the mountain (16.91km away), since it's supposedly a malfunctioning ICBM, it would have been extremely loud and there does not seem to be any reports describing any noise. Also, since there was no eyewitness accounts of any missile part(s) being explicitly visible, this low limit assumption seems more than fair.

In the upper limit, we will assume the missile malfunctioned no further away than directly above the White Sea (911.22km away). Once again, this seems like a vast over estimation given that the great amount of reports came from northern Norway. Then, mathematically,

$$d_{spiral} \in (16.91\text{km}_{(\text{low limit})},\ 911.22\text{km}_{(\text{high limit})}) \quad \ldots[6] \ .$$

It is now our task to calculate the height of the center of the spiral in both limits. This will give us a means of measuring the wavelength, λ . Let us define a few terms,

$h_{\text{spiral}} \rightarrow$ The physical height of the center of the white spiral (measured from the Horizon-Line).
$d_{\text{spiral}} \rightarrow$ The physicl distance to the white spiral's center (measured along the ground).

……[8]

A) Lower Limit:

In the lower limit, d_{spiral} is defined as 16.91km

km,

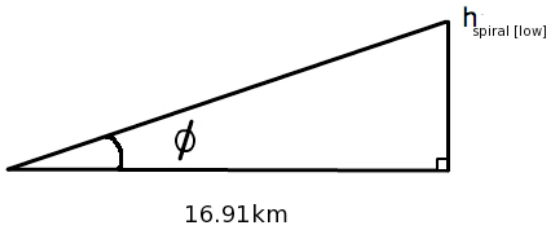


FIG. 8

Then,

$$h_{\text{spiral [low]}} = 16.91\text{km} * \tan[\phi] = 2.99\text{km} \quad \ldots[8]$$

Pugging [8] into [5], then using [4] we find

$$\underline{\lambda_{[low]} = 316.58\text{m}} \quad \ldots[9]$$

B) Upper Limit:

In the upper limit, d_{spiral} is defined as 911.22km,

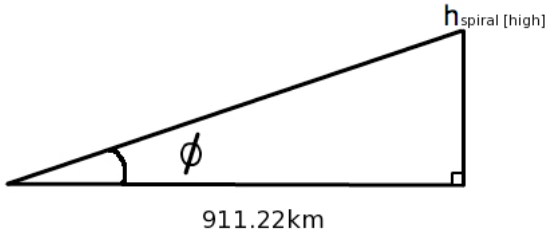


FIG. 9

Then,

$$h_{\text{spiral [high]}} = 911.22\text{km} * \tan[\phi] = 161.26\text{km} \quad \ldots[10]$$

Pugging [10] into [5], then using [4], we find

$$\underline{\lambda_{[high]} = 17{,}074\text{m}} \quad \ldots[11]$$

From the well known expression for the velocity of a wave,

$$f * \lambda = v \quad \ldots[12]$$

we can derive the magnitudes of the velocity in each limit.

We have found the wavelength for two limiting cases. One in which the white spiral is directly above the mountain, at a distance of about 16.91km and the other in which the spiral is directly above the White Sea, at a distance of 911.22km.

Recall from before:

$$f = 1\,\text{Hz} \text{ , then}$$

$$\therefore \underline{|v_{[low]}| = 316.58\text{m/s}} \quad \ldots[13]$$

$$\therefore \underline{|v_{[high]}| = 17{,}074\text{m/s}} \quad \ldots[14]$$

5. CONCLUSIONS:

Using relative proportions as they appear in PHOTO 1, the spiral's known (estimated) frequency of rotation (~1Hz) and the known geographical measurements of the terrain in PHOTO 1, we found a relative expression (Eq. 5) for the velocity of the spiral's "ripples". Evaluating this expression for two limiting cases, (above the mountain and above the White Sea) we found the velocities in expressions [13] and [14].

Now we must take some extra information into account:

a) possible sources of error,
b) the specifications of the Bulava-class SLBM,
c) the speed of sound at different altitudes, and
d) the general behavior of body re-entering the atmosphere.

A. Possible Sources of Error:

There are clear and distinct sources of error that must be addressed in this report. First and foremost, the measurements taken from the picture are rough at best and do not reflect any distortions caused by the lens and/or camera. Additionally, it was assumed that the distance to the spiral and mountain were straight lines and did not reflect the actual curvature of the Earth's surface. Using the known radius of the Earth, the distance to the White Sea (the upper limit), and some more trigonometry, it can be found that height of the spiral (Eq. 10) should be ~14km higher (~8.7%). This would only increase the velocity of the "ripples" slightly and thus can be ignored in light of the accuracy of the available data.

B. Specifications of the Bulava-class SLBM:

The "official characteristics as declared under START-2 Treaty[3]" of the "RSM-56" Bulava SLBM state that all 3 stages are fueled by solid propellant. This would rule out the possibility of the "ripples" being liquid or gas propellant particulate. It seems to only leave the possibility that the "ripples" could be smoke. Yet the proposed smoke is moving over 300m/s (over

3 http://www.astronautix.com/lvs/bulava.htm

twice the fastest recorded wind speed of 318mph) in the lower limit alone. One would presume that the smoke would defuse and dissipate in an easily observable rate- yet all accounts of the event in question indicate the "ripples" moved at a constant velocity while maintaining perfect geometric form.

C. The Speed of Sound at Different Altitudes:

The speed of sound varies in different layers of the atmosphere[4]:

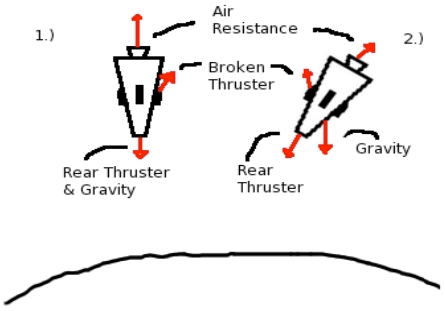
Atmospheric Region	Altitude			Speed of Sound Behavior
	miles	1000 feet	kilometers	
Exosphere	310.7	1640.4	500.0	Undefined
Thermosphere	55.9	295.3	90.0	Increasing
Mesopause	53.4	282.2	86.0	Constant
Mesosphere	31.9	168.7	51.4	Decreasing
Stratopause	29.4	155.3	47.4	Constant
Stratosphere	12.5	65.8	20.1	Increasing
Tropopause	6.8	36.2	11.0	Constant
Troposphere		sea level		Decreasing

The atmosphere is said to cease around 122km- the speed of sound becoming undefined in this region. The highest altitude for which there is a known speed of sound is around 122km, at 308m/s. Now, since there is no report of any "sonic booms" (or any other noise) associated with this event, if the "ripples" were smoke, they would have to occur above 122km. This raises the question, "how come people in northern Norway and Finland captured such clear photographs and videos, including many from cell phones, and no one in Sweden, Russia, or Estonia reported anything?"
Perhaps weather could be attributed to the lack of a clear sky, but surely the entire region could not have been *completely covered.*

D. The General Behavior of a Body Re-Entering the Atmosphere:

As the missile's bus (the 3rd stage housing for all the warheads) re-entered the atmosphere, it was under the force of its thrusters (1 on the end and 3 or 4 on the sides), the Earth's gravitational field, and the resistive force of the atmosphere. The bus could be positioned, relative to the Earth's surface, in one of two ways:

1) pointing straight down or
2) at an angle



Yet, the white spiral is in the plane of the picture! If a broken side-thruster created it while the missile bus re-entered the atmosphere, the smoke should have been ejected in a fashion similar to the blue spiral. The evidence states that the

4 http://www.aerospaceweb.org/question/atmosphere/q0112.shtml

missile would then have to traveling straight towards or away from the photographer in Skjervøy, which, if launched from the White Sea, would indicate a highly improbable missile trajectory. Now, in the either case of a normal re-entry, if one side thruster malfunctioned and was continuously firing, the missile would spin faster and faster under this constant angular force, until it reached a maximum. Furthermore, it would seem necessary that the maximum angular frequency of the missile be much greater than 1Hz. Yet, from all the available evidence, the source of the spiral begins spinning at ~1Hz and continues at this rate until it disappears fully, never increasing.

The data available thus far does not support the hypothesis that the spirals were caused by a malfunctioning missile's exhaust. T*he "ripples" in question are traveling extremely fast and are too geometrically perfect to be smoke.* Also, the white "smoke exhaust" indicates a highly improbable re-entry trajectory and the angular frequency of the object does not change nor increase sufficiently above 1Hz. Whereas if a missile were to be under a constant angular force while re-entry, it would presumably rotate *much* faster than once every second. Finally, the lack of pressure waves or any other sound (a.k.a. "sonic booms") and sightings outside of northern Norway and Finland further corrode the possibility that the spirals were caused by a broken missile re-entering the atmosphere.

Thank you.