

A Unified theory of Superman's Powers

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Abstract

Since Time immemorial, man has sought to explain the powers of Kal-El, a.k.a. Superman. Siegel *et al.* Supposed that His mighty strength stems from His origin on another planet whose density and as a result, gravity, was much higher than our own. Natural selection on the planet of krypton would therefore endow Kal El with more efficient muscles and higher bone density; explaining, to first order, Superman's extraordinary powers. Though concise, this theory has proved inaccurate. It is now clear that Superman is actually *flying* rather than just jumping really high; and His freeze-breath, x-ray vision, and heat vision also have no account in *Seigel's* theory.

In this paper we propose a new unified theory for the source of Superman's powers; that is to say, all of Superman's extraordinary powers are manifestation of one supernatural ability, rather than a host. It is our opinion that all of Superman's recognized powers can be unified if His power is the ability to manipulate, from atomic to kilometer length scales, the inertia of His own and any matter with which He is in contact.

1 Introduction

Kal El, or Superman, has a host of recognized powers which seem to have no unifying cause. These powers include the ability to move quickly, resistance to physical damage, extreme strength, the ability to fly, x-ray vision, heat vision and freezing breath.

It is our contention that all of Superman's abilities can be explained by supposing that Superman has the ability to alter His own inertia, and the inertia of objects with which He is in contact. While we have come up with no physical explanation for this singular supernatural power, or how it relates to the light of our Sun; we feel that unifying His abilities clarify the issue for future research. In this paper we will categorize His abilities and explain each power in turn; and then explain how Superman's conjectured power can be used to generate each effect.

2 Physical Powers

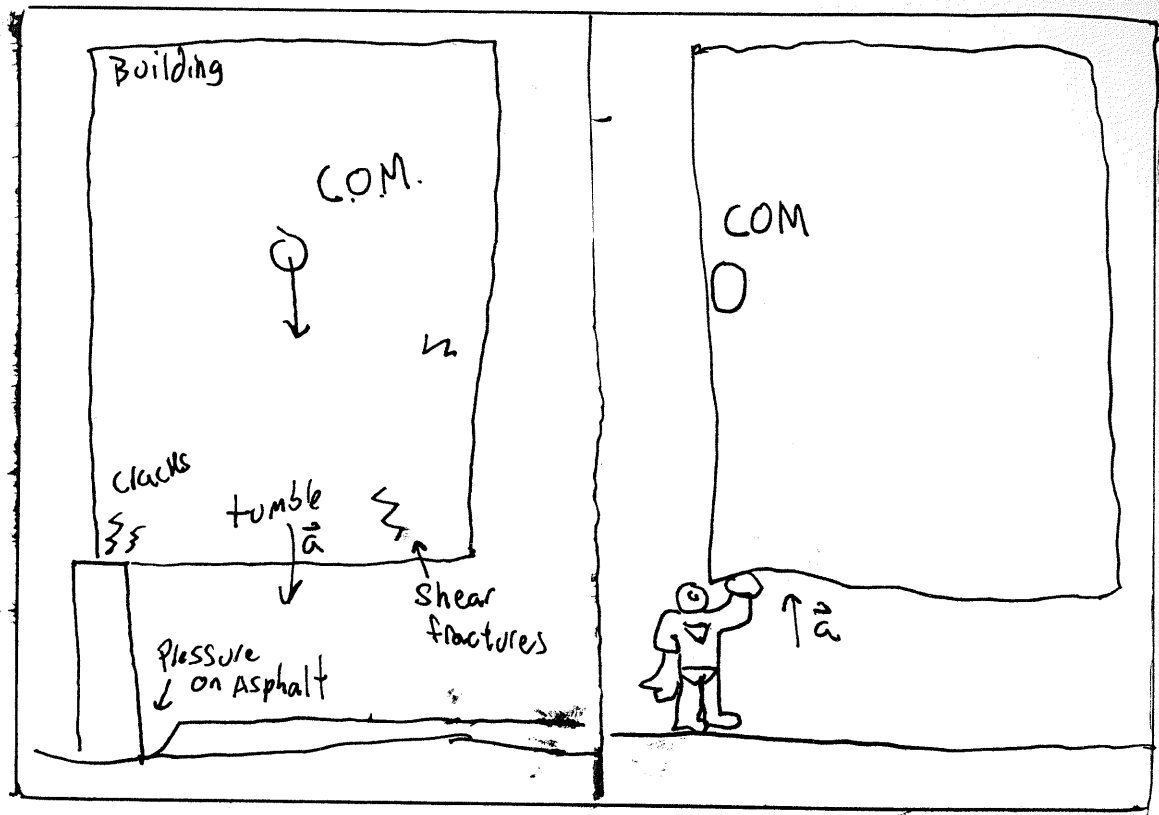
In this section we argue that there is evidence that Superman can alter the moment of inertia or inertial mass of macroscopic objects.

2.1 Super Strength

Superman's extraordinary strength is somewhat of a mystery, since it seems at times to not satisfy Newton's laws. Imagine Kal El lifting an office building over His head, one handed, while walking down the street. The feat of strength itself is not just unbelievable, but also unphysical. Consider figure 1. If we were to position a multi-storied office building upon on a post on a street, to be held from the same position as we imagine Superman holding it: the building above the post would crack from the enormous pressure; as would the pavement beneath the post. Since the post would not lie beneath the building's center of mass, we would expect to see the building either tumble forward, or we would see the building crack from the shear stresses which come from being held by the corner.

In contrast, we see none of these effects when Kal El lifts an object. We can only conjecture that Superman has the ability to move the center of mass (by controlling the moment of inertia) of the office building. In addition, the lack of deformation of the pavement (though the pressure beneath His feet as He walks must be intense), and the lack of damage at the point of contact of the building tell us that He must have also somehow reduced the effective mass of the building.

Figure 1.



2.2 Flight

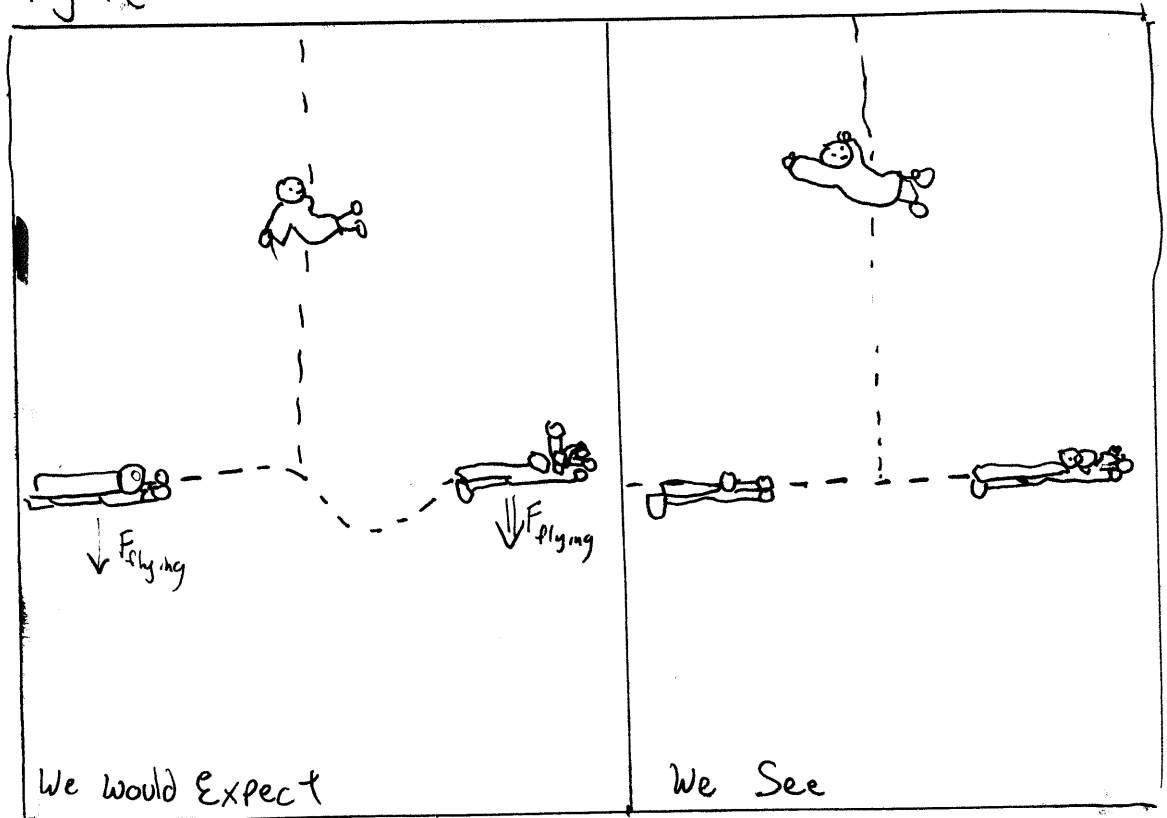
Superman's ability to fly also gives evidence supporting our conjecture. According to our conjecture, flight could be achieved if Superman were to lower by His own mass, and increase the mass of the air with which He is in contact. Flight could then be achieved and sustained by pushing the ambient "heavy" air about him. This mechanism, however, does not confine him to Earth's atmosphere; since even outer space is not a perfect vacuum. It's nonzero density should provide enough dust and gas for Him to accelerate by pushing Himself off of it (in addition, He might be accelerate by selectively radiating high intensity photons).

Our conjecture does not only suggest a mechanism for His flight, but it also clarifies some issues concerning how He has been observed interacting with

objects, in flight. Imagine the familiar scenario where a heavy stewardess falls from an airplane, and then Kal El intercepts and catches her, mid flight. This Scene is illustrated in figure 2. If Superman obeyed the laws of physics we would expect that, once Superman caught the stewardess, their collective trajectory would suffer as a result of her monstrous initial momentum. Additionally we would generally expect her to be crushed under the large acceleration, and torn into pieces by the considerable impulse.

However, from experience, Kal El rarely dips after catching someone midair. This seems only possible if, somehow, Superman were able to reduce the momentum of the caught person. Furthermore, the caught person reports feeling much pressure or acceleration from Superman's arms. If the stewardess' moment of inertia were dramatically reduced prior to the impact of Kal El's arm, her body would suffer less from the impulse, as it would be lightly felt.

Figure 2



2.3 Super Speed

While Kal El's high running speed and heavy acceleration could be explained in terms of extreme physical strength; we would expect, if this were the case, the street beneath His feet to warp or shatter under the intense pressure. Since this is rarely in evidence, we deduce that His high acceleration comes not from His exerting an almost infinite force, but rather from His having an arbitrarily small mass.

3 Super Senses

In addition to His feats of strength, Kal El also possesses super-senses. He can hear a broader range of sounds and see a wider spectrum of electromagnetic waves than we (humans) can. We feel that these can be best explained in the context of our conjecture as an ability to alter the inertial mass of parts of His own sensory organs. We note, however, that the following explanations are conjecture; since Kal El's highly tuned senses might simply be a matter of Kryptonian physiology.

3.1 Super Hearing

Superman can hear sounds across a broader frequency than we humans can, and He can also hear sounds which are much quieter and tolerate sounds which are much louder than can humans. Though the specific mechanism by which Kal El hears is not understood, it is reasonable to expect that it functions internally in a way analogous to our own ears. An increase in sensitivity, as well as a resistance against hearing loss could be explained if He were to make the various components of His ears lighter or heavier alternatively, without altering the mechanism of hearing. An increased frequency range of hearing could be created by generating temperature or density gradients in the air, or within the components of His ear, shifting the sounds into His audible range.

3.2 Super Sight

Similarly the specific mechanism through which Superman's nerves perceive light is not clear. While His ability to see a wider spectrum of light than we can may just be a matter of Kryptonian physiology, it seems strange that His eyes should be able to see into the x-ray part of the spectrum. Indeed, we wonder where all the x-rays Kal El can see come from. We would expect that in most situations, it would be too dim to see much in the x-ray spectrum.

Our conjecture provides an alternate explanation. If Superman were able to alter inertial mass on the scale atoms and molecules, we would expect that He could alter the emission/absorption spectrum of atoms or molecules. Consider the simple case of the hydrogen atom. Ordinarily, the energy contribution from the gravitational potential is neglected; however it can easily be re-introduced. The potential energy in the hamiltonian goes from

$$V = -\frac{k_1 e^2}{r} \rightarrow -\frac{k_1 e^2 + k_2 m M}{r}$$

where m is the electron mass, M is the nuclear mass, k_1 is the appropriate coulomb coupling, k_2 is the gravitational coupling, and $k_1 \gg k_2 > 0$. The addition of the gravitational term will shift the Eigenvalues of the quantum states:

$$E_n = -\frac{1}{2\hbar^2} \frac{mM}{m+M} \frac{k_1^2 e^4}{n^2} \rightarrow -\frac{1}{2\hbar^2} \frac{mM}{m+M} \frac{[k_1 e^2 + k_2 m M]^2}{n^2}$$

thus the radiated/absorbed frequencies will be

$$\nu = \frac{\Delta E}{h} = \frac{1}{h} \frac{1}{2\hbar^2} \frac{mM}{m+M} [k_1 e^2 + k_2 m M]^2 \left[\frac{1}{n_i^2} - \frac{1}{n_f^2} \right]$$

So we note that altering the inertial masses of the components of the hydrogen atom can shift the absorption/emission spectrum.

He could then use His ability to shift the band of frequencies to which His eyes are sensitive. This action could also solve the “x-ray dimness” problem, since He could shift His own thermal radiation from the infra-red to the x-ray band.

3.3 Super Disguises

While it is not clear where Kal El goes when He is not busy saving the world; if our conjecture is sound, He could apply His power in creating a convincing disguise, and mingle with the human world unnoticed. For instance, by making the components of His face heavier He could cause His cheeks and forehead to sag; reducing the impression of His striking granite jaw line. He could increase or decrease the weight of His hair in places, making it lay flat or stick up. He may even be able to shift emission spectra of the colour pigments in His irises, changing His eye colour. While these few changes might seem slight, human facial recognition is a subtle business, and can easily be fooled.

In addition to changing His face shape, we imagine that He could wear a pair of heavy prescription glasses. While ordinary glasses may not distort the appearance of a person; if the lenses were large and strong enough they could effectively make the wearer unrecognizable to a casual observer by repositioning His eyes on His face and magnifying their size (thereby altering the ratios between the eyes and the rest of the face). Ordinarily, wearing heavy prescription glasses would not be functional as a disguise; but Kal El should be able to alter the density of the vitreous humour in His eyes, thereby altering its optical properties. We deduce that Kal El should be able to provide Himself with a hidden “adaptive optics” system to compensate for having to see through thick lenses.

4 Freeze-Breath and Heat Vision

Kal El's most exotic powers could be His ability to freeze objects with His breath, or alternatively emit "heat beams" from His eyes. These two powers have been the most difficult to explain, but they fit well with our conjecture that Kal El can alter the inertia of the molecules of a gas with which He is in contact.

In addition to His Freeze-Breath and Heat Vision, Kal El has indirectly provided evidence of His ability to control the temperature of the gas around him. His frequent visits to the Sun and the Earth's polar regions without having to change his clothing, for example. We cannot count this as conclusive evidence for our conjecture, though, since other explanations could be imagined. Thus, we focus our attentions on attempting to provide a mechanism for his ability to "glare fire", and "breath ice".

4.1 Freeze Breath

In gasses, the temperature of the gas is related to the average kinetic energy of the particles in the gas. If Superman were able to reduce the inertial mass of the air molecules in His lungs, as He exhaled, the air would be colder than when it went in.

$$T_{in} = \frac{1}{3k_B} m_{in} \langle v^2 \rangle \geq \frac{1}{3k_B} m_{out} \langle v^2 \rangle = T_{out}$$

To facilitate expiration of the cold gas, the process could be isobaric. Thus for an ideal gas,

$$P \frac{3V}{m \langle v^2 \rangle} = N$$

we see that the number of gas molecules in Kal El's lungs must increase inverse-proportionally with the decreased mass.



4.2 Heat Vision

Similarly, if Superman were able to increase the mass of selected gas molecules moving away from His eyes, this would effectively create a stream of “hot” gas originating at His eyes.

Lets assume that N atoms per second are deflected off His eye and directed towards the target. This number is of course dependent on the active area of His eye A , the temperature T and density of the air ρ , and of the average mass of the air molecules m ; but it is also depende nt on the solid angle of His target and His own sensitivity and capacity to select individual molecules, Ω .

$$N = \frac{\rho}{4} \sqrt{\frac{8kT}{\pi m}} \frac{1}{m} A \Omega$$

Let us suppose that the target of His “heat vision” is a box full of an ideal gas which contains a constant number of atoms, M . The temperature of the

target will initially be

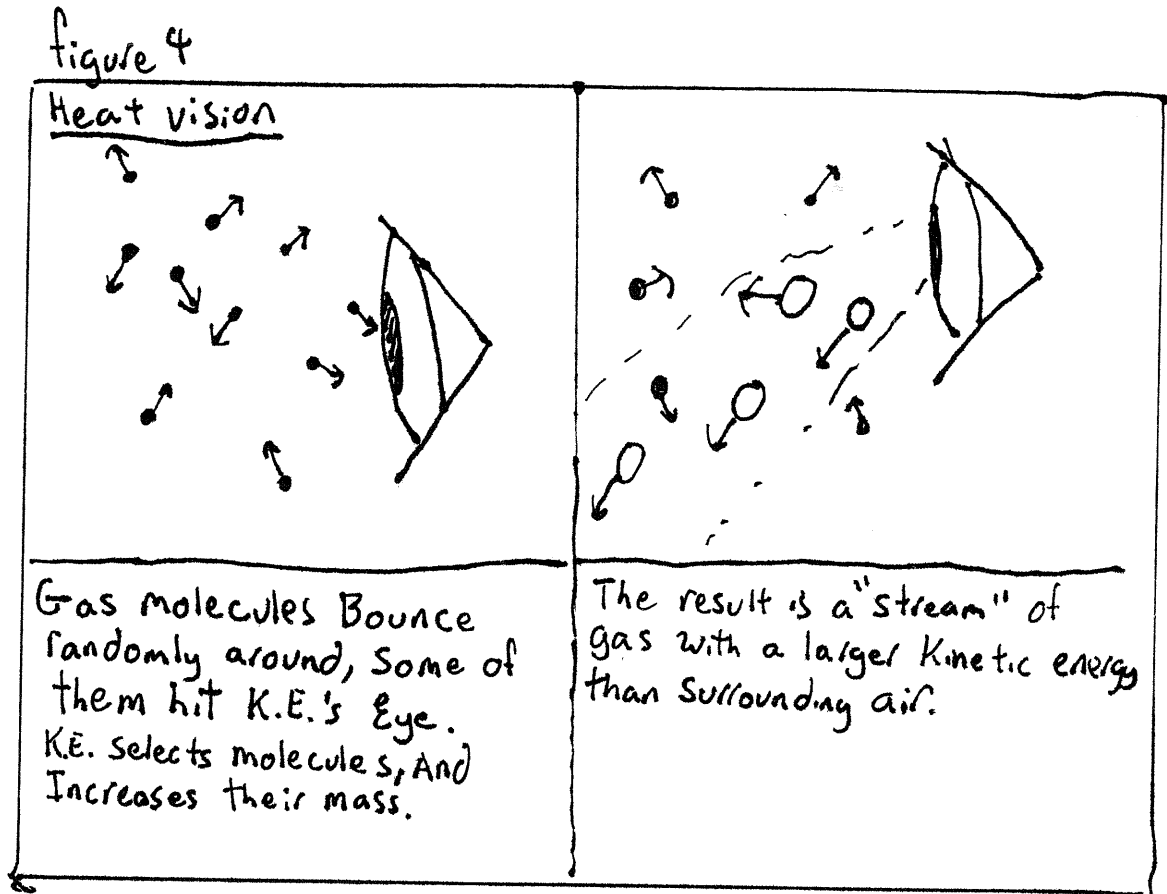
$$T_i = \frac{1}{3k} \langle mv^2 \rangle = \frac{1}{3k} \frac{Mm_i \langle v^2 \rangle}{M}$$

where m_i is the original inertial mass of the gas molecules. If these becomes m_f after hitting Superman's eye; then after He's engaged His "heat vision" the temperature of the target will be:

$$T = \frac{1}{3k} \langle mv^2 \rangle = \frac{1}{3k} \frac{(M - Nt) \langle m_i v^2 \rangle + Nt \langle m_f v^2 \rangle}{M}$$

$$T = \frac{MT_i - NtT_i + Nt \frac{m_f}{m_i} T_i}{M} = T_i + t \frac{N}{M} \left(\frac{m_f}{m_i} - 1 \right) T_i$$

So we can roughly estimate that the temperature of the object Kal El is heating with His heat vision will increase linearly with time.



5 Conclusion

We conjecture that all of Superman's powers come from His ability to alter the inertial mass of objects in His immediate vicinity or with which He is in personal contact; although the mechanism is unknown.

Our conjecture of a single unified power could be tested in a few simple ways. We could, for instance, determine whether Superman could accelerate if He were surrounded by a nearly perfect vacuum. Alternatively, We could determine whether He has the ability to emit x-rays, and whether He can actively change His transparency to x-rays. We could test His "heat vision" to determine whether there are limits to the ratio $\frac{m_f}{m_i}$; and to what degree the changes he makes will persist. shut up.