

No Amount of Red Light Breaks What Blue Light Breaks

— A **700 nm** photon carries **170.90 kJ/mol** and cannot reach the **305** of a C--N bond; only light shorter than **392.2 nm** can — fading is set not by brightness but by the energy of a single quantum — [Paper 448]

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— *From thinking to syncing.* —

Abstract

Shine strong light and it will break—so it is thought. This paper shows that if the energy of one photon does not reach the bond, no number of photons will break it—so fading is decided by colour, not brightness. No new theorem or law is claimed. First, a 700 nm photon carries 1.7712 eV, that is 170.90 kJ/mol (Section 2). Second, at 400 nm this becomes **3.0996 eV**, 299.07 kJ/mol, a factor of 1.75 (Section 2). Third, this is the core of the paper. Only light shorter than **392.2 nm** can break a C--N bond (305 kJ/mol); red light holds only 170.90 and never reaches it (Section 3). Fourth, each bond has its own threshold wavelength—**343.8 nm** for C--C and **334.2** for C--O (Section 3). Fifth, raising the intensity does not move that boundary (Section 3). Sixth, the separator is whether the total acts or a single quantum acts (Section 4). **Keywords:** photochemistry, photon energy, bond dissociation energy, photodegradation, laws of photochemistry.

Scope of this paper (scope note): No new theorem or law is claimed—the light quantum hypothesis, bond dissociation energies and the first and second laws of photochemistry are all standard. No material is designed—choice of dye, UV absorbers and protective coatings are not the subject. No mechanism is argued—excited state lifetimes, intersystem crossing and the role of oxygen are not the subject. The bond energies are representative—they shift by tens of kJ/mol between molecules. What is being looked at is that a boundary exists, not exactly where. Multiphoton processes are excluded—two-photon absorption occurs at very high intensity but is negligible under ordinary lighting. No rate is discussed—how many years fading takes is not the subject; only whether the bond can break. Relation to earlier papers: Paper 447 showed that added workers flow out of the exit—there too, there was a place where adding more did not help. Paper 300 showed that common root and distinct root can be decided—“total energy” and “energy per quantum” are distinct roots by that criterion. Paper 446 showed that a floor moves with the demand—there too, a quantity stated without its condition misled. What is added is tabulating photon energies at four wavelengths, giving threshold wavelengths for three bonds, placing the 392.2 nm of C–N as the boundary, showing numerically that red light at 170.90 falls short, and placing the separator at total versus single quantum.

1. Notation and the Question

Setting: The energy of a single photon of wavelength λ is

$$E = \frac{hc}{\lambda}$$

and per mole one multiplies by N_A .

$$E_{\text{mol}} = \frac{N_A hc}{\lambda}$$

A bond of dissociation energy D can break only when $E_{\text{mol}} \geq D$, so the threshold wavelength is

$$\lambda_{\text{max}} = \frac{N_A hc}{D}$$

and nothing longer than this can break it.

Observation 1.1

Shine strong light and it will break—so it is thought. Pour in energy and the bond eventually gives—the picture of heat.

Observation 1.2

But light arrives in countable pieces. One photon meets one bond—they cannot be added together and spent.

Question: Which colour reaches which bond.

2. Photon Energy Differs by a Factor of 2.33 Across Colour

Computation 2.1: Take the photon energy at four wavelengths.

Wavelength [nm]	Photon [eV]	Per mole [kJ]
700 (red)	1.7712	170.90
550 (green)	2.2543	217.50
400 (violet)	3.0996	299.07
300 (UV)	4.1328	398.76

Observation 2.2

From red to ultraviolet, a factor of 2.33. From 1.7712 to 4.1328 eV—even across the visible range alone it is 1.75.

Observation 2.3

This difference has nothing to do with intensity. A photon of dim ultraviolet still carries 4.1328 eV—a photon of bright red light still carries 1.7712.

3. Only Light Shorter Than 392.2 nm Breaks C–N

Computation 3.1: Take the threshold wavelength for three bonds.

Bond	D [kJ/mol]	$\lambda_{\max}$ [nm]
C--C	348	343.8
C--N	305	392.2
C--O	358	334.2

Observation 3.2

Even the weakest of the three, C--N, sits at 392.2 nm. Even the violet edge of the visible is essentially on the boundary—the 299.07 kJ/mol of 400 nm falls just short of 305.

Observation 3.3

Red light holds only 170.90 kJ/mol. That is 56.0 per cent of the 305 of C--N—a little over half, and no amount of it will break the bond.

Observation 3.4

The boundary differs by bond.58 nm between the 334.2 of C--O and the 392.2 of C--N—the same light breaks one bond and not another.

Observation 3.5

Raising the intensity does not move that boundary. Multiply the photons by 10^6 and each still carries 1.7712 eV—a threshold that cannot be crossed by counting is the point here.

Observation 3.6

So cutting the ultraviolet stops the fading. This is why window glass and films work—they do not reduce the brightness, they remove the short side.

4. The Separator

The separator: does the total act, or does a single quantum act.

Observation 4.1

If the total acts, raising the intensity suffices. Heat is of that type—any colour will do if enough is poured in.

Observation 4.2

If a single quantum acts, only the colour can change the outcome. Photochemistry is of that type—gather any number of insufficient photons and they remain insufficient.

Observation 4.3

These are distinct roots by the criterion of Paper 300. Both are called “energy”—one the size of a flow, one the size of a single handover.

Observation 4.4

The same shape as Paper 447. There, adding workers exceeded what the exit could hold—here, adding photons does not enlarge any one of them. In both, more of the same does not help.

Observation 4.5

So when protection is considered, look at the spectrum first. Not the total illuminance but the short-wavelength part—at equal brightness, different sources fade at different rates.

Observation 4.6

To be honest—the bond dissociation energies are representative values. They shift by tens of kJ/mol between molecules—what is being looked at is that a boundary exists, not exactly where.

Observation 4.7

One last thing—two-photon absorption can occur at very high intensity. Then two quanta are handed over at once—negligible under ordinary lighting, but it is recorded here as the reason the boundary is not absolute.

5. Roll Call and Closing

1. 700 nm is 170.90 kJ/mol (Computation 2.1): red light.
2. 400 nm is 299.07 (Computation 2.1): a factor of 1.75.
3. Red to UV is 2.33 (Observation 2.2): set by colour.
4. Independent of intensity (Observation 2.3): dim light still carries it.
5. The C--N threshold is 392.2 nm (Computation 3.1): the core.
6. Red is 56.0 per cent of 305 (Observation 3.3): it does not reach.
7. C--O is 334.2 nm (Computation 3.1): each bond differs.
8. Intensity does not move it (Observation 3.5): counting cannot cross it.
9. Cutting UV stops it (Observation 3.6): remove the short side.
10. The separator is total or single (Observation 4.3): distinct roots by Paper 300.

Closing: Shine strong light and it will break—so it is thought—the picture of heat, in which pouring in energy eventually gives. But light arrives in countable pieces: one photon meets one bond, and they cannot be added together and spent. The size of a single photon is set by colour—1.7712 eV, that is 170.90 kJ/mol, at 700 nm; 217.50 at 550; 299.07 at 400; 398.76 at 300. A factor of 2.33 from red to ultraviolet, and 1.75 across the visible alone. And the difference has nothing to do with intensity: a photon of dim ultraviolet still carries 4.1328 eV, and a photon of bright red light still carries 1.7712. On the other side there is a threshold—nothing longer than 343.8 nm breaks C--C, 392.2 breaks C--N, or 334.2 breaks C--O. Even the weakest of the three sits at 392.2 nm, and the 299.07 kJ/mol of 400 nm light falls just short of 305. Red light holds only 170.90, which is 56.0 per cent of the C--N bond—a little over half, and no amount of it will break the bond. The boundary differs by bond, 58 nm between C--O and C--N, so the same light breaks one and not another. And raising the intensity does not move it: multiply the photons by 10^6 and each still carries 1.7712 eV, because a threshold cannot be crossed by counting. So cutting the ultraviolet stops the fading—window glass and films do not reduce the brightness, they remove the short side. One thing separates them—does the total act, or does a single quantum act. If the total acts, raising the intensity suffices, and heat is of that type. If a single quantum acts, only the colour can change the outcome, and photochemistry is of that type: gather any number of insufficient photons and they remain insufficient. They are distinct roots by the criterion of Paper 300, one the size of a flow and one the size of a single handover. It is the same shape as Paper 447, where

adding workers exceeded what the exit could hold: in both, more of the same does not help. So when protection is considered, look at the spectrum rather than the total illuminance—at equal brightness, different sources fade at different rates. To be honest—the bond dissociation energies are representative and shift by tens of kJ/mol between molecules. What is being looked at is that a boundary exists, not exactly where. One last thing—two-photon absorption can occur at very high intensity, handing over two quanta at once. It is negligible under ordinary lighting, but it is recorded here as the reason the boundary is not absolute.

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