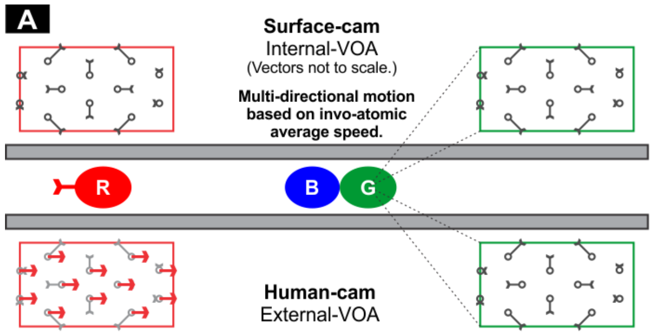


Forces Are Atomic Momentum Transfer Rates!

Professor Du-Ane Du

www.Wacky1301SCI.com, *"Looking at serious science, sideways!"*

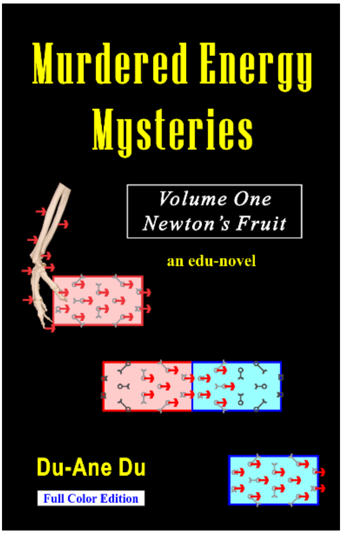
> Three sisters, Pico, Hectii, and Tera, the "Space-sci Sherlocks," are traveling through the Asteroid Belt. Pico and a friend do virtual collision experiments to see how atomic momentum causes surface forces.
> —Excerpted from *Murdered Energy Mysteries*, Part 1, Chapter 4, by Du-Ane Du, (Amazon, Kindle, ebook 2018, paperback 2021).

"My legs are becoming tired, Femton, I need to take a break," Pico disclosed, as she reached into the virtual goal-net and pulled out a hockey puck. She turned and waved at the virtual image of a familiar classmate—a young man of average height, with spiked hair and energetic eyes. "I'm glad you called, Femton, it seems like forever since you went to the Gravity Spa for your fluctuating-gravity treatments."

"I'm glad you suggested we play virtual space hockey," Femton said merrily. "Dad says we can play for another hour or so, then our spaceships will be too far apart for us to communicate in real time. Did you learn anything interesting while I was away?"

"Right now, we're learning about atomic momentum force-rates, also known as contac-ρ-force-rates," Pico said. "Force-rates tell us how fast the atoms of one object transfer momentum into another object."

Excerpted from:



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"Seriously? Like the atoms in a hockey stick pushing against a space-hockey puck?" Femton asked enthusiastically, his words piling on top of each other. "Can you show me some atoms doing this?"

"Maybe," Pico said. "Chip, can you modify our virtual space-hockey program so that we can shoot hockey pucks down a narrow track? We'll do a Space-sci Sherlock experiment!"

"Yes," Chip said, using the fatherly bass voice that Femton had established when he initiated the ship-to-ship call. "Do you wish to perform some collision experiments? If so, I recommend pucks made from C-12 diamonds—they'll give you the most accurate results."

"Use whatever kind of material you think is best," Pico said. "We'll need three pucks, let's say 0.5 kg per puck, put two pucks in the middle of the test track, and I'll hit one down the track."

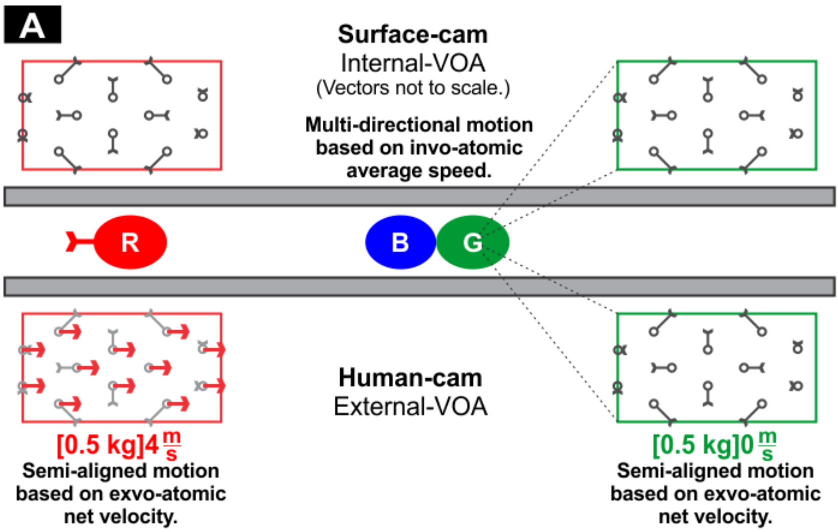
"This is exciting," Femton said. "Can we see the atoms too?"

"Yes," Pico said as she prepared to hit the first puck. "Chip, set up the usual atomic view cameras."

"Got it," Chip said, "and I'll time each of the collisions and measure the velocity of each puck."

"Give it a good whack," Femton said, his eyes wide with encouragement. "Chip, place a data screen on the left side of our visor-displays so we can see what's happening to the atoms."

Pico viciously swung her stick at the virtual puck, and Chip placed the first picture on their visor-displays.



"Lots of things happening," Femton admitted. "Explain what the cameras are doing."

"There is surface-cam on to each of the pucks," Pico said, "surface-cams show us the invo-atomic motion. Femton, invo-atomic means INternal View of the Object's atoms. The invo-atomic average speed relates to… explain it again, Chip."

"The motion of the atoms inside an object can be analyzed from two different perspectives," Chip said. "The **invo-atomic average forward speed** measures the average speed of the atoms with respect to the sides of the object. The invo-atomic average speed relates to the object's temperature."

"And invo-atomic momentum?" Pico tenderly prompted.

"If you multiply the invo-atomic average speed by the mass of the monatomic object," Chip said, "it will tell you the

invo-atomic total s-momentum inside the object. S-momentum is speed-based momentum."

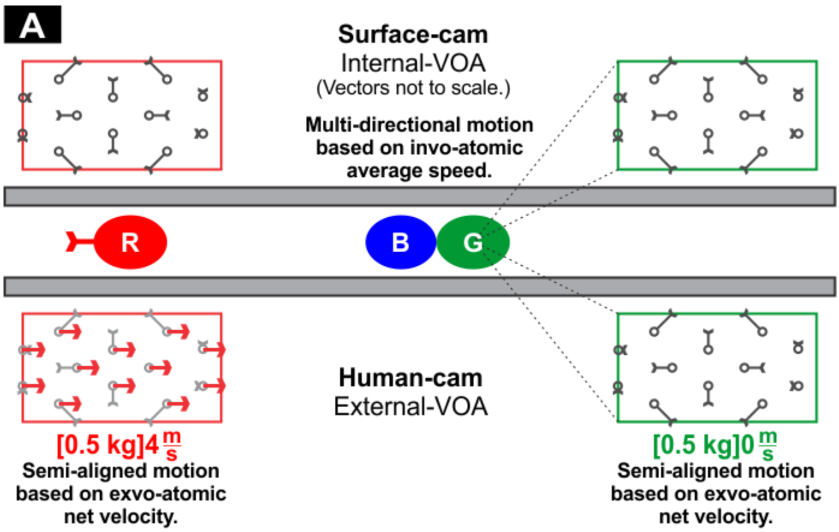
"Is there another perspective?" Femton queried.

"Exvo-atomic motion," Pico said. "That's what the human-level cameras show."

"What's exvo-atomic mean?" Femton said.

"Exvo-atomic means the EXternal View of the Object's atoms," Pico said. "It relates to the directional velocity of the atoms. What was the term, Chip?"

"**Exvo-atomic net velocity** tells us the net velocity of the atoms in the object with respect to the external environment," Chip said. "If you multiply the exvo-atomic net velocity by the mass of the object, it will tell you the **exvo-atomic total v-momentum** of the atoms in the object. V-momentum is directional velocity-based momentum, and the exvo-atomic v-momentum is always equal to the object's human-level momentum."



"This is amazing," Femton declared. "In the surface-cam pictures—at the top of our screens—the INternal View of the Object's (INVO) atomic-motion shows that each of the pucks has the same invo-atomic average speed."

"Since this is a virtual environment," Chip said, "I set the temperature of your experiment so the invo-atomic average speed is 20 m/s. All three pucks have the same temperature and the same mass, so they all have the same invo-atomic average speed, and the same invo-atomic total s-momentum."

"At the bottom of the screen," Femton said, "the human-cam pictures show that the red puck on the left has an exvo-atomic net velocity of 4.0 m/s…"

"That corresponds to the puck's human-level velocity," Pico said. "The green and blue pucks have an exvo-atomic net velocity of 0 m/s, which means they're not moving."

"How big of a whack did you give the puck?" Femton said inquisitively. "Can you measure the size of the whack, or maybe calculate the size of the whack?"

"I think so," Pico said as, she activated her data-input gloves. "The puck wasn't moving before I whacked it, so it had a starting velocity of 0 m/s, and Chip measured its final velocity as 4.0 m/s. Chip, display my figures below the pictures."

"Continue, and I'll also display them for Femton to see," Chip said.

"Ok, when I gave the puck a whack I exerted an impulse—the scientific word for a whack is an impulse," Pico clarified, as she and began tapping the keys in her data-input gloves. "The calculations for the impulse [momentum transfer] are:"

$$im\Delta\rho \text{ transferred to puck} = mv_{final} - mv_{initial}$$

$$im\Delta\rho = \left([0.5\ kg]4\ \frac{m}{s}\right) - \left([0.5\ kg]0\ \frac{m}{s}\right)$$

$$im\Delta\rho = \left(2\ kg\frac{m}{s}\right) - \left(0\ kg\frac{m}{s}\right)$$

$$\boldsymbol{im\Delta\rho \text{ transferred to puck} = 2\ \rho}$$

appeared below the illustration.

"The whack involved 2.0 momentums of impulse," Femton said. "Is that a lot?"

"It's probably not as much impulse as you can produce," Pico said daintily. "The other day we learned that a whack also involves a momentum transfer rate. Chip, how long did my whack take?"

"Your virtual hockey stick was in contact with the red puck for 0.1 s," Chip said.

"I can do this," Pico said confidently, keying while she talked. "The momentum force-rate can also be called a contac-ρ-force-rate. And in this case, the calculations for the stick/ puck force-rate are:"

$$S/P\ \rho\text{-}\underline{\boldsymbol{F}}orce\text{-}rate = \frac{im\Delta\rho}{time}$$

$$S/P\ \rho\text{-}\underline{\boldsymbol{F}}orce\text{-}rate = \frac{2\ \rho}{0.1\ seconds}$$

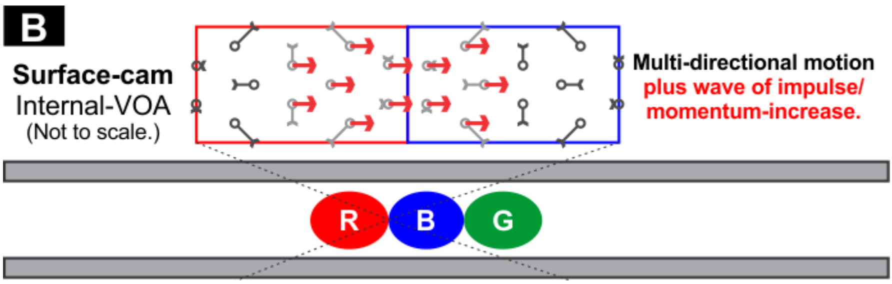
$$\underline{\boldsymbol{F}} = \mathbf{20}\ \frac{\rho}{s}\text{, or } \mathbf{20}\frac{kgm}{s^2}\text{, or 20N, for 0.1 s.}$$

appeared below the illustration.

"The numbers are telling us that during the whack, the stick transferred momentum to the puck at a rate of 20 ρ, momentums per second," Femton summed up. "That's amazing, Pico. You're good at this! Can we see what happens when the red puck hits the blue puck?"

"Yes," Pico said. "Show us the next pictures, Chip."

"Here," Chip said, placing the following illustration on the left side of their visor displays:



Femton's brows knitted in thought, "Let's see if I can figure out what's happening here. It looks like all three of the pucks are stopped. And the cameras are focused on the contact point between the red and blue pucks."

"I think that's called an atomic interface," Pico postulated.

Femton's avatar grinned hysterically. "Last year my science teacher told us, an **atomic interface** is the contact surface between two objects. When you put an ice cube in a glass of water, there's an ice/water atomic interface, an ice/air atomic interface, and a water/air atomic interface."

"I like your ice-and-water example."

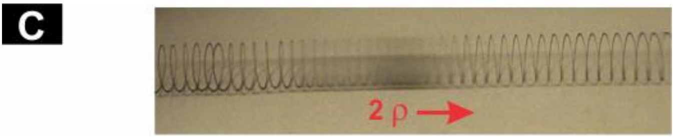
"I guess there's also a glass/water atomic interface."

"And in this case, there's a red-puck/blue-puck atomic interface," Pico said. "The atomic interface must be where the momentum is transferred from one puck to the other."

"Looking at the top, surface-cam picture, it appears that the atoms inside the pucks are shifting to the right," Femton surmised. "It's kind of like dominoes tumbling down."

"Fascinating," Pico said. "It looks like a red wave of impulse—it must've come from the red puck."

"Excellent deduction, Pico," Chip said, as he retrieved a picture from his memory banks and placed it on their visor-displays. "An **impulse wave**-pulse, also known as an **invo-atomic impulse wave**, is a lot like a compression wave-pulse moving through a child's springy toy. See how this wave is moving to the right?"



"We did that in science class last March," Femton said proudly. "My teacher told us, when we watch a compression wave-pulse move through a springy toy, we can see that momentum tends to continue moving forward."

"The same thing must be happening in our diamond-puck collision," Pico concluded. "The carbon atoms in the pucks are so tightly packed together that as soon as the two pucks touch, the r-s-t momentum moves atom-by-atom from the red puck and into the blue puck."

"Which means, the red/blue atomic-interface is serving as the transfer point between the two pucks," Femton said. "The r-s-t momentum is leaving the red puck, going through the red/blue atomic interface, and entering the blue puck. Pico, can you calculate the contact force-rate that is occurring at the atomic-interface?"

"If I estimate the time," Pico said cautiously, keying as she talked. "We already know that the impulse wave consists of 2.0 ρ of rightward impulse. If it takes…I'll say 0.01 s. That means the calculations for the red/blue force-rate are:"

$$R/B\ \rho\text{-}\underline{\mathbf{F}}orce\text{-}rate = \frac{im\Delta\rho}{time}$$

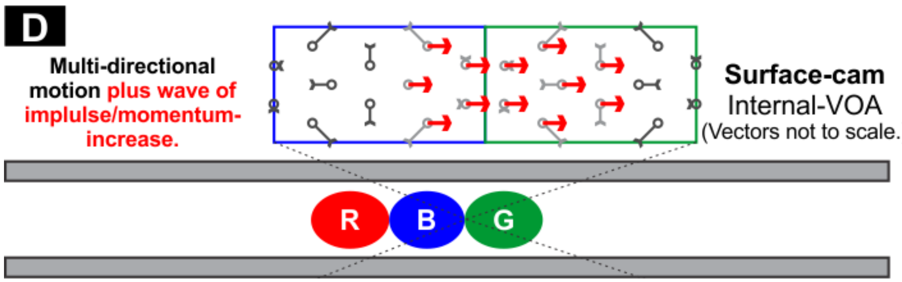
$$R/B\ \rho\text{-}\underline{\mathbf{F}}orce\text{-}rate = \frac{2\ \rho}{0.01\ seconds}$$

$$\underline{\boldsymbol{F}} = \mathbf{200}\ \frac{\rho}{s},\ \boldsymbol{or}\ \mathbf{200}\ \frac{\boldsymbol{kgm}}{\boldsymbol{s^2}}\ \boldsymbol{for\ 0.01\ s.}$$

appeared below the illustration.

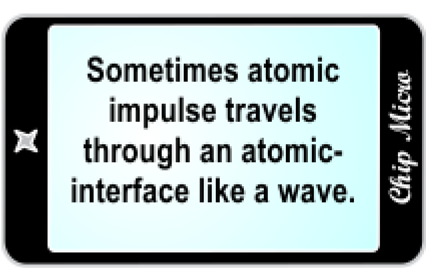
"200 momentums per second (ρ/s) seems like a big force-rate," Femton said. "And to think all that momentum came from your arm!"

"Chip," Pico said. "Show us what happens when the invo-atomic impulse wave passes through the blue/green atomic-interface:



“Explo!” Femton said with a touch of awe. “The wave of momentum has continued moving to the right without changing much.”

“Invo-atomic impulse waves behave exactly like sound waves,” Chip said. “If there’s no gap between pucks, and if the pucks are made of the same material, then the impulse wave will usually continue moving from atom-to-atom and from puck, to puck, to puck. Because the pucks are made of diamond, the impulse wave can pass through dozens of pucks at amazingly high speeds.”



“Let me calculate the ρ-force-rate,” Femton volunteered, as he activated his data-input gloves. “Chip, about how long did it take for the 2.0 ρ of atomic momentum to move from the blue puck to the green puck?"

"Diamonds are very dense, and the impulse wave will travel very fast," Chip said. "Therefore, a more realistic estimate of the time for the blue/green momentum transfer is about 0.001 s."

"Thanks, Chip," Femton said, as he hurriedly keyed. "Based on your time estimate, the calculations for the blue/green, force-rate are:"

$$B/G\ \rho\text{-}\underline{\boldsymbol{F}}orce\text{-}rate = \frac{im\Delta\rho}{time}$$

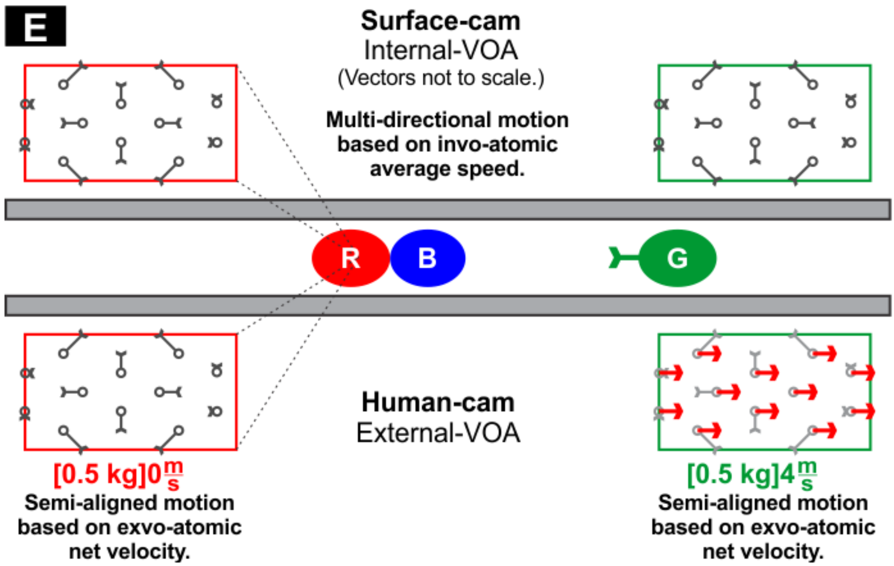
$$B/G\ \rho\text{-}\underline{\boldsymbol{F}}orce\text{-}rate = \frac{2\ \rho}{0.001\ seconds}$$

$$\underline{\boldsymbol{F}} = 2\ 000\ \frac{\rho}{s},\ or\ 2\ 000\ \frac{kgm}{s^2}\ for\ 0.001\ s.$$

appeared below the illustration.

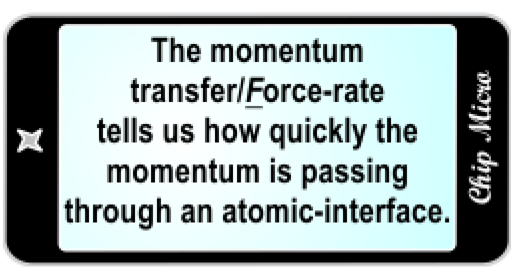
"Fabulous job, Femton," Pico lauded. "Your figures tell us, the blue/green atomic interface transferred the momentum at a rate of 2 000 momentums per second. Chip, show us what happened when the invo-atomic impulse wave reached the end of the green puck."

"Here," Chip said, as the next pictures appeared on the left side of their visor displays:



"This is mindboggling," Femton said. "To think that Pico's whack first gave momentum to the red puck—"

"—when the red puck hit the blue puck," Pico continued, "the momentum became an invo-atomic impulse wave that moved atom-by-atom through the red/blue atomic-interface—"



"—then atom-by-atom the impulse wave went through the blue puck," Femton extended, "and the impulse wave went through the blue/green atomic-interface and into the green puck—"

"—when the impulse reached the end of the green puck," Pico completed, "the green puck moved forward as if I had hit the green puck with my hockey stick!"

"Momentum and impulse [momentum transfer] are like magic," Femton said with an air of admiration. "You hit the red puck, and the green puck is the one that ends up moving!"

"Almost as magical as a visit to the Gravity Spa," Pico said with a laugh. "You arrive sitting in a wheelchair, revolve for a few weeks, and walk out on two feet."

"It's pretty crazy," Femton said. "I can't believe how quickly it worked. And it'll work for you too."

"We've certainly learned a lot so far," Pico said as she studied the last collision picture. "Now we need to check to see if we've discovered some type of scientific fact."

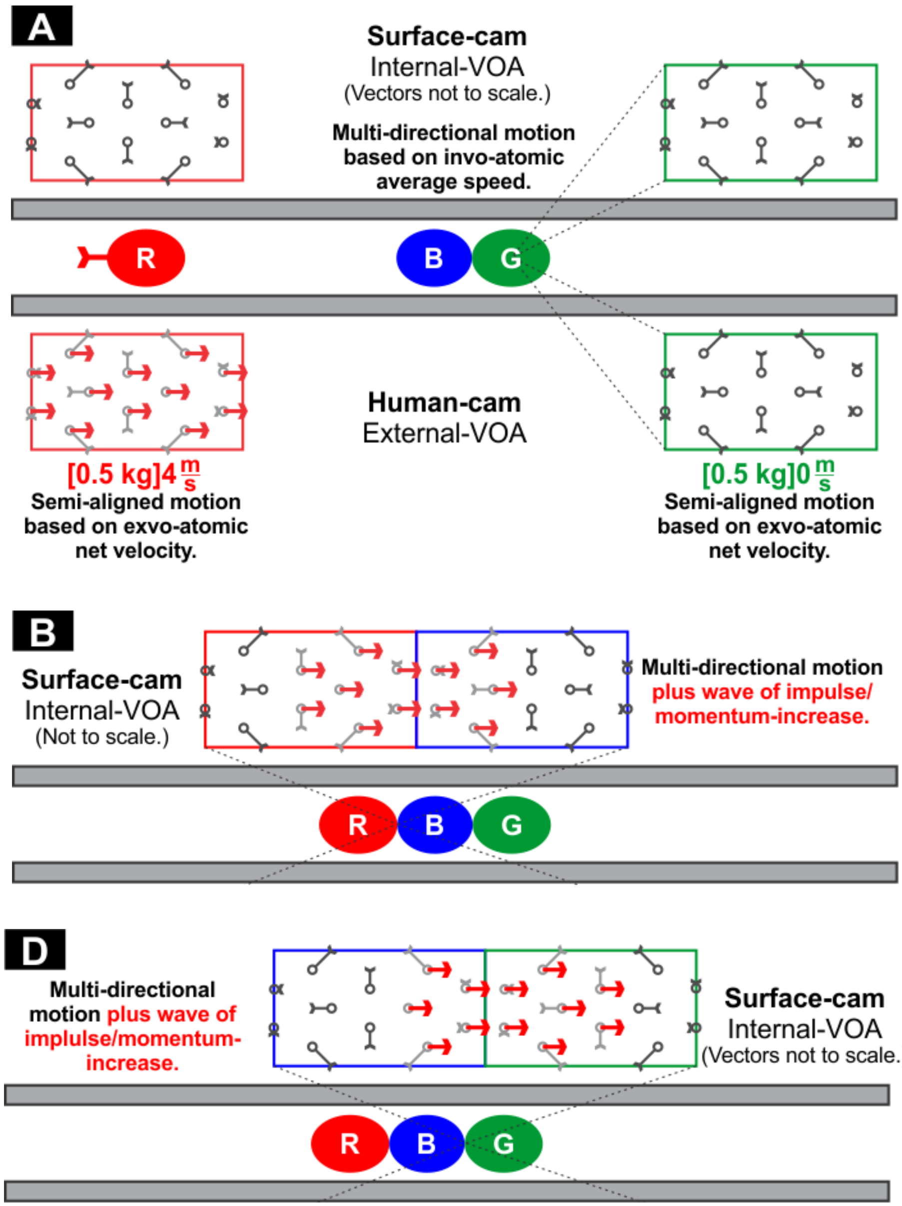
"Are scientific facts important?"

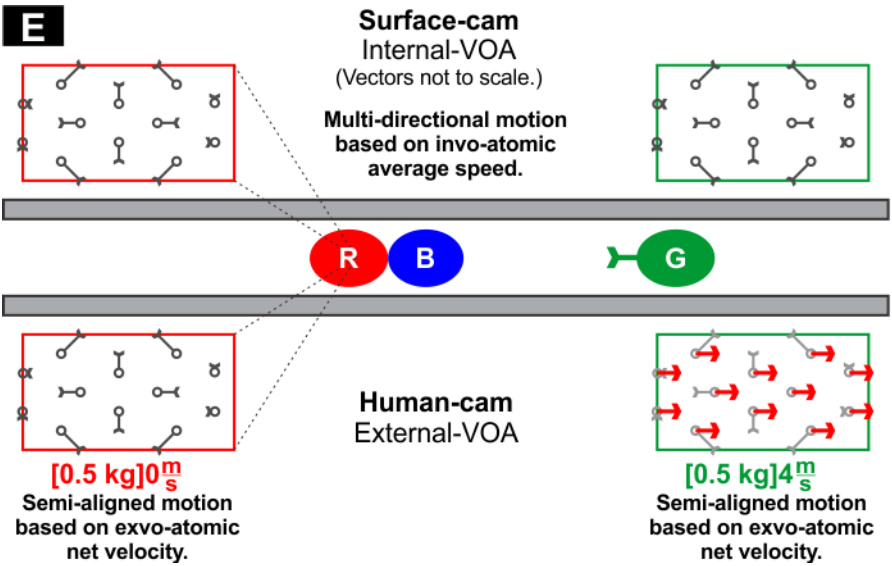
"Of course," Pico said. "The Space-sci Sherlocks always focus on the facts."

"Interesting," Femton said. "But, how do we know if we stumbled on a new fact?"

"Chip," Pico requested, "show us the collision pictures, in order."

"Here," Chip said as the following appeared on their screens:


A
Surface-cam
Internal-VOA
(Vectors not to scale.)
Multi-directional motion based on invo-atomic average speed.
R
B
G
Human-cam
External-VOA
[0.5 kg]4 m/s
Semi-aligned motion based on exvo-atomic net velocity.
[0.5 kg]0 m/s
Semi-aligned motion based on exvo-atomic net velocity.
B
Surface-cam
Internal-VOA
(Not to scale.)
Multi-directional motion plus wave of impulse/ momentum-increase.
R
B
G
D
Multi-directional motion plus wave of implulse/momentum-increase.
Surface-cam
Internal-VOA
(Vectors not to scale.)
R
B
G



"I detect a series of three force-rates," Femton articulated. "You applied a force-rate to the red puck, the red puck applied a force-rate to the blue puck, the blue puck applied a force-rate to the green puck."

Pico's avatar crossed its eyes absurdly. "Strangely enough, it began as an exvo-atomic force-rate, became an invo-atomic impulse wave, and changed back into an exvo-atomic force-rate."

"Chip," Femton said. "Have scientists always known about exvo-atomic force-rates?"

"Definitely not," Chip said. "The ancient philosopher Aristotle taught, objects move because forces push them around."

“So, from Aristotle’s perspective,” Femton interpolated. “Pico exerted a force-rate on the red puck, the red puck exerted a force on the blue puck, and the blue puck exerted a force on the green puck—causing the green puck to move!”

“Wait!” Pico said. “That’s where the scientific fact is. Human level contact forces are actually caused by exvo-atomic force-rates!”

“And they occur at the atomic-interface between two objects,” Femton said. “What should we call this fact?”

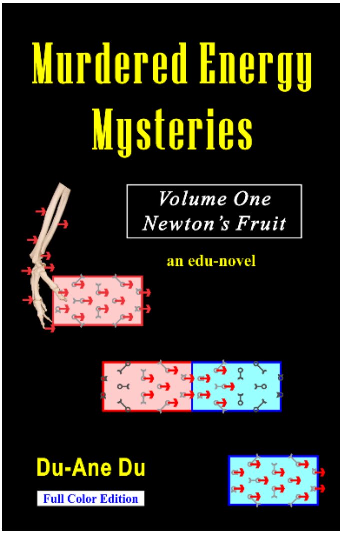
Pico released a soft whistle. “How about, the exvo-atomic fact #1 of contact forces.”

“I love it,” Femton said.

“And the **exvo-atomic fact #1 of contact forces** tells us, human-level contact forces are the direct result of exvo-atomic momentum being transferred across an atomic interface from Object A to Object B. The level of force is identical to the momentum transfer rate across the A/B atomic interface.”

“And the equations match each other,” Femton said as he activated his data-input gloves and keyed:

Excerpted from:



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ρ-***F**orce-rate* = (*im*$\Delta\rho$)/*time*

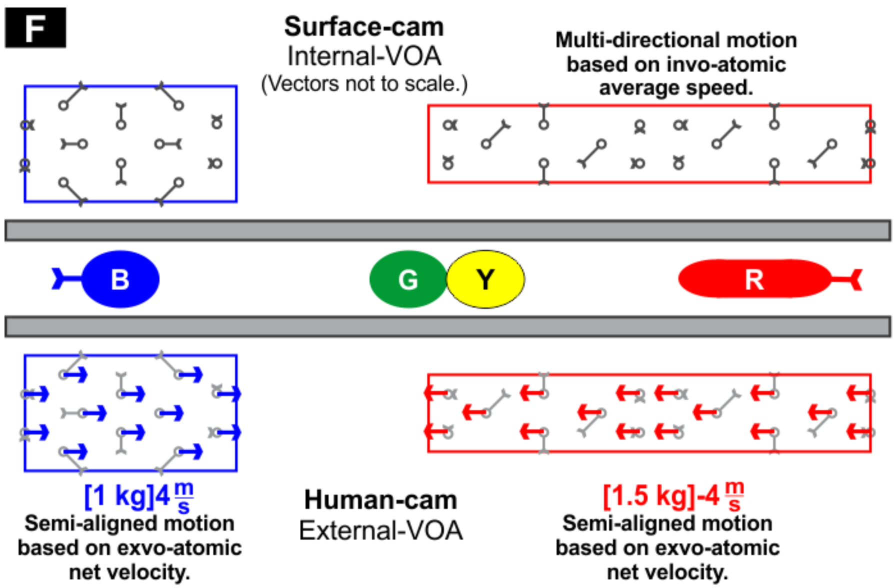
force = *impulse/time*

appeared on their displays.

"Excellent job," Pico expressed. "How much longer can we play? Do we have time…"

Femton dexterously keyed in an interface command. "Mom, we're doing an important experiment, can we…thanks, Mom. Pico, my Mom says our ship-to-ship communication signal may start degrading before too long, but we can continue virtual-visiting for another 30 minutes or so. Let's hit two pucks this time!"

"Three, two, one…"



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Murdered Energy Mysteries seeks to increase understanding of the various forms of momentum and momentum transfer, as well as the various forms of energy and energy transfer. The lack of understanding on the part of the scientific community is substantial, and more research needs to be done.

—Du-Ane Du, author of the edu-novel *Murdered Energy Mysteries* (Amazon, Kindle, e-book 2018, paperback 2021.)

More information, visit www.Wacky1301SCI.com