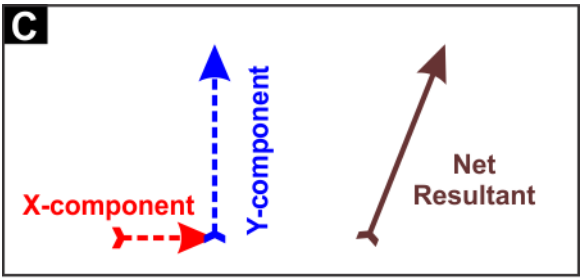
The Space-sci Sherlocks Deduce



Speed-Momentum Dominates Velocity-Momentum

Professor Du-Ane Du

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

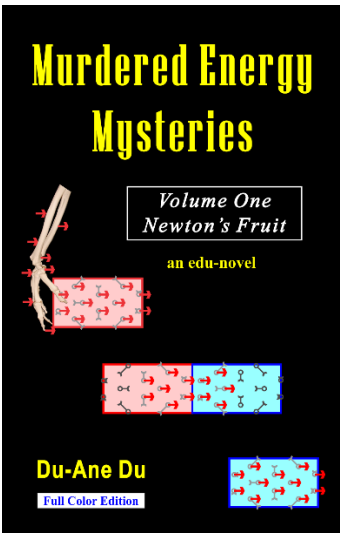
Three sisters, Pico, Hectii, and Tera, the "Space-sci Sherlocks," are traveling through the Asteroid Belt. Pico and Grandpa Proge play virtual games and discover why speed-momentum dominates over velocity-momentum.
—Excerpted from *Murdered Energy Mysteries*, Part 1, Chapter 2, by Du-Ane Du, (Amazon, Kindle, ebook 2018, paperback 2021).

"Now we head upriver to grab a jar of magic health-potion, Grandpa," Pico said, as she turned their virtual powerboat around, peddled as fast as she could, and deftly steered the speeding powerboat up the rapids and around rocks and boulders—right, left, right, straight, left…

"What's the health potion for?" Proge asked.

"Every time I play this exercise-game, I can't move past Level 13, but I think the solution is…"

Excerpted from:



Examine or purchase at Amazon.com

3D virtual visor over her eyes and data-input gloves on her hands, Pico was riding a stationary bicycle, situated at the end of their space-ship's long, narrow exercise-area. She peddled so fast that the bicycle bounced wildly on the bungee cords that held it in place. Thanks to the bungee cords, her erratic move-ments didn't disturb the spaceship nor its other occupants.

In Pico's 3D virtual world, Grandpa Proge's image was sitting to her right as she steered their speedboat around the jagged rocks. Proge was viewing Pico's exercise session from the porch of his elegant retirement home overlooking the shore of a small Hawaiian island. Because of the vast distances be-tween Earth and the Asteroid Belt, Proge could speak with Pico, but he couldn't move his avatar with precision.

"There it is," Pico said, as her avatar pointed at a glow-ing potion-bottle that was hanging above the rapids in front of them. In a single motion, Pico powered down, swerved, grabbed the bottle of potion, and then the engine revved loudly

as their boat shot down the river rapids—racing past the rocks and boulders at twice the previous speed.

"What's the magic health-potion for?" Proge repeated several seconds later.

"I'm not certain," Pico admitted.

Pico and her sisters always enjoyed their conversations with Grandpa Proge, and they had become used to the long delays between their questions and Proge's answers. Sentences interspaced with gaps of silence were the nature of communications between their home on Mars Colony and Grandpa Proge's home on Earth.

"There on the left," Pico said, as she raced toward the right side of a large island she pointed to a swirling, tornado-like cloud left of the river. "I have to take the right fork… the left fork is too shallow. But there on the left is a vortex in the sky. As soon as I move around this island… Chip, prepare to put the health potion into the engine's fuel injectors, I have an idea."

"Ready," Chip said.

The powerboat flew off a waterfall, glided down into a canyon, and landed in the swirling water—sending a splash high up the cliff face. The cliff on the left ended abruptly, and Pico turned hard left.

"Careful, the two rivers are merging," Proge warned. "The cross-current will tip us over!"

"Now, Chip!" Pico shouted, as she peddled her exercise bicycle even faster.

As the magic health-potion entered the engine, the virtual powerboat lurched forward, up onto a trio of hydrofoils, and across the foaming current. A jagged cliff face appeared in front of them, and the tornado vortex above opened wider.

"We're heading for a cliff," Proge gently cautioned.

Pico's avatar pressed the seat ejection button, and both avatars suddenly rocketed upward into the tornado vortex. The sky swirled around them. Patches of light flashed in the clouds, and then they were enveloped in total darkness.

"Yes, Level 14," Pico declared victoriously, as their avatars landed on two giant diamonds. All around them, diamonds, emeralds, and rubies—each the size of a dinner plate—glided rapidly through the air at a wide variety of speeds and angles. "This must be the Jewel Level."

"It does appear that way," Proge said.

"I need a rest," Pico said. She peddled slower, and her avatar sat on its diamond.

"That was fascinating," Proge said. "Thanks for inviting me to attend one of your exercise sessions."

"I just love this new level of the exercise game," Pico expressed, looking around. "All the huge diamonds and emeralds gliding through the room at different angles. Say, while

we're resting, would you like to help me solve a puzzle question?"

"Happy too," Proge said encouragingly.

"Chip," Pico said. "Does *Secrets of Murdered Energia* have a riddle that relates to the exercise game we're doing?"

"Sort of," Chip said. "How's this? Develop equations for total momentum, average momentum, and net momentum."

"Do you know anything about momentum, Grandpa? Does this sound like a question we can work on together?"

Professor Emeritus, Paul "*Prog*ressive-*Pro*ge" Dypes' avatar remained motionless as he softly chuckled, "Yes, I know a little about momentum. Can you tell me the difference between velocity and speed?"

"Yesterday we learned that **momentum** is associated with the equations *ms* and *mv*," Pico said. "I think *mv* relates to velocity, and *ms* relates to speed. But I'm not certain what the difference is."

"Speed is a type of measurement we call a **scalar**. Which means, we record how large speed is, but we do not record its direction," '*Prog*ressive' *Pro*ge explained. "Velocity is a type of measurement we call a **vector**, which means we record both the size and the direction of the measurement.

"Chip, open a textbox in the lower part of our displays," Proge requested. "As I key, place the information into the textbox. Pico, these're the ideal equations for speed and velocity:"

> *velocity*: °*v*
> *or velocity*: +*v*, *or* –*v*
> *speed*: |*s*|
> *or speed*: |*v*|
> appeared in the textbox.

Pico laughed playfully as she watched a virtual-ruby glide behind the textbox and reappear on the other side. She moved her head and the virtual-textbox moved with her—as if the textbox were attached to an invisible glass sphere that surrounded her head.

"Grandpa, I like these symbols. You included a direction symbol along with the velocity symbol. That means plus and minus must be directions, so forward must be plus, and backward must be minus."

"Excellent deduction."

"I like that word, deduction," Pico said. "We're calling ourselves the Space-sci Sherlocks, and deducing is what Sherlocks are supposed to—

"—oh, and the speed symbol is inside an absolute value symbol," Pico said, interrupting herself. "That means speed

doesn't involve direction—and even if you accidentally include a positive or a negative symbol, then the absolute value symbol will cause the answer to always be positive."

"Exactly, speed is always positive—no matter what direction the object is going. In fact, ever notice that a speedometer never has negative values on it?

"I'm not old enough to drive a spaceship," Pico said with a giggle. "But you're right, speeds are always positive."

"Excellent," Proge praised. "And when we add two speeds, we call it a **total speed**, but when we add two velocities, we call the answer a **net velocity**. Now, can you guess what the equations for total momentum and net momentum are?"

Pico activated her data-input gloves and began keying letters into the textbox. "That would involve total s-momentum, and net v-momentum. Because the letter 's' represents speed, and the letter 'v' represents velocity. If I'm guessing correctly, the equations should work like this:"

> ***speed-momentum*: |*ms*|**
> *or speed-momentum*: |*mv*|
> *velocity-momentum*: °*mv*
> ***or velocity-momentum*: +*mv*, or –*mv***
> appeared in the textbox.

"Oh," Pico said, as her fingers rapidly clicked the keys in her data-input gloves. "You asked about total and net. Those equations should be:"

> ***total s-momentum*: $|ms|_1 + |ms|_2 + |ms|_3$ …**
> *total s-momentum*: $|mv|_1 + |mv|_2 + |mv|_3$ …
> ***net v-momentum*: $°mv_1 + °mv_2 + °mv_3$ …**
> appeared in the textbox.

"All of those are correct," Proge said proudly. "You did a fabulous job. Now, think back to when you were racing the boat up the river to grab the magic health-potion. Which equations would you use to determine the momentum of the powerboat as it passed the rocks?"

"Chip," Pico requested. "Give me a printout of the speed of the river by itself, the speed of the powerboat by itself, and the mass of the powerboat."

"The boat is involved in two situations," Chip said. "I'll use the label *river* to indicate the speed of the boat if the river is flowing but the motor is off. And I'll use the label *motor* to indicate the speed of the boat when the river is not flowing but the motor is running. How's this look:"

> *mass of powerboat and riders*: *300 kg*
> *speed river-only: 40 m/s*
> *speed motor-only*: *100 m/s*
> appeared in the textbox.

"Simple enough," Pico said, as her fingers keyed. "If the boat motor was not running, then the river would've caused the boat to have an s-momentum of:"

$$\textit{river-boat s-momentum} = |ms|$$
$$\textit{river-boat s-momentum} = |(300\ kg)(40\ \tfrac{m}{s})|$$
$$\boldsymbol{\textit{river-boat s-momentum} = 12\ 000\ kg\tfrac{m}{s}}$$

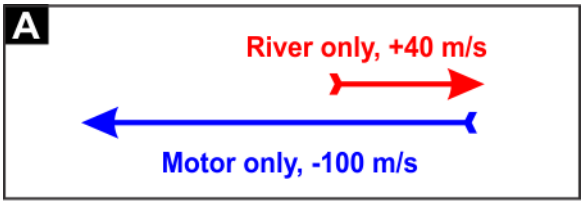
"If the river was not moving," Pico continued, "and the motor was running, then the motor alone would've caused the boat to have an s-momentum of:"

$$\textit{motor-boat s-momentum} = |ms|$$
$$\textit{motor-boat s-momentum} = |(300\ kg)(100\ \tfrac{m}{s})|$$
$$\boldsymbol{\textit{motor-boat s-momentum} = 30\ 000\ kg\tfrac{m}{s}}$$

"But the river was flowing, and the motor was also running," Pico recalled. "Which means, to find our momentum as our boat passed the rock, all I have to do is add—no wait! We were going upriver. I can't add. There was a direction involved. What do I do, Grandpa?"

"You have to use vectors," Proge responded, a professorial tone entering his voice. "Here, let me help you out. We'll say that the river was flowing east. And we'll define east as positive. We'll say that the boat was going west, and west is

negative. To help us visualize this, we'll draw an arrow picture. An arrow picture is called a **vector diagram**. I've placed a vector diagram in the textbox, does this help?"



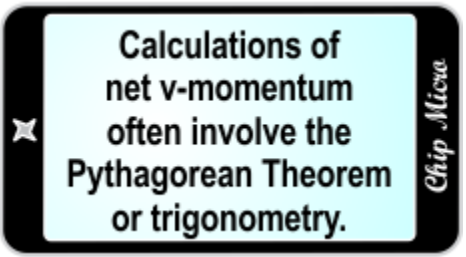
"That helps a lot," Pico said, as she began keying. "Which means, now we're dealing with vectors. And we call vector momentum, velocity-momentum or **v-momentum**. When you add two vectors, the answer is called net. That means the calculations for our net v-momentum as we passed the rock are:"

$$net\ v\text{-}momentum = °mv_{river} + °mv_{motor}$$
$$net\ v\text{-}momentum = (300\ kg)(+40\ \tfrac{m}{s}) + (300\ kg)(-100\ \tfrac{m}{s})$$
$$net\ v\text{-}momentum = (+12\ 000\ kg\ \tfrac{m}{s}) + (-30\ 000\ kg\ \tfrac{m}{s})$$
$$net\ v\text{-}momentum = -18\ 000\ kg\ \tfrac{m}{s}$$
$$\mathbf{net\ v\text{-}momentum = west\ 18\ 000\ kg\tfrac{m}{s}}$$

appeared in the textbox.

Pico's avatar grinned proudly, "These equations tell us, the boat had a net westward v-momentum of 18 000 kgm/s."

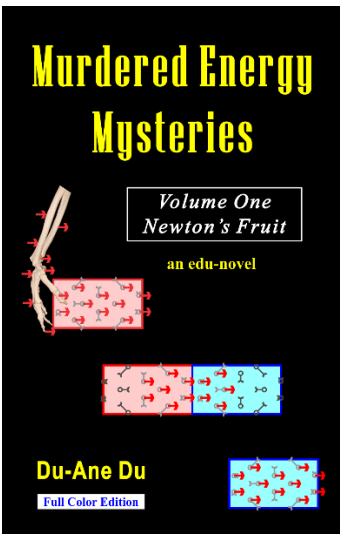
"You did wonderfully," Proge congratulated. "And you are correct. As we passed the rocks, the powerboat's net v-momentum was 18 000 kgm/s west, or you could say it was 18 000 kgm/s upriver, or –18 000 kgm/s, since negative often means west. Are you ready to resume your exercise game?"



Pico started peddling a little faster. In the 3D virtual world, a pair of diamonds crossed in front of her. "Let me loosen up a little first. Give me one more puzzle-question. Can we do one involving the jewels that're flying around in this amazing room?"

"Certainly. The jewels appear to be flying in straight lines. They're flying at different angles, but the path is straight and they aren't changing speeds."

Excerpted from:



Examine or purchase at Amazon.com

"That would be **Newtonian motion fact #1B**," Pico said. "You know, a moving object won't stop moving in a straight line unless it experiences an impulse, a series of impulses, or a continuous unbalanced momentum transfer."

"I love your version of Newton's first law," Proge lauded. "That's very precise and very descriptive."

"We decided that we should focus on scientific facts more than we focus on philosophical precepts or human laws."

"Interesting point," Proge said. "Now, do you know what an impulse is?"

"Of course," Pico confidently stated, as she began keying letters into her data-input glove. "An **impulse** is a measure of the amount of momentum that's been transferred to an object during a brief push, or it's a measure of the amount of momentum that's been transferred away from an object. The equation for impulse is:"

$$im\Delta\rho = mv_{final} - mv_{initial}$$

appeared on their displays.

"Oh, and impulse can also involve the transfer of momentum from a spinning object to an object that moves in a straight line. Spinning objects have radian/rotational momentum, or r-momentum. R-momentum is omnidirectional.

"If you think about it," Pico expanded, "an impulse is non-directional in nature—because it can involve speed-momentum, or radian-momentum, or it can involve something called trapped impulse. T-impulse is also omnidirectional."

"That was a marvelously detailed explanation," Proge said sincerely. "Ok Chip, what's the forward speed and mass of the diamonds that're gliding through this virtual room?"

"There are 10 diamonds, 10 rubies, and 10 emeralds flying through this room," Chip said. "The diamonds all have a mass of 1.0 kg, and they're traveling at a constant speed of 30 m/s."

"Great," Proge said. "Now Pico, can you figure out how much impulse it took to cause these 10 diamonds to fly across the room?"

"I think so," Pico said, as she stopped peddling and began keying faultlessly. "Let me focus on one diamond. The calculations for the impulse needed to cause one diamond to move across the room…oh, let's begin by finding the s-momentum:"

1 diamond, s-momentum = $|ms|$
1 diamond, s-momentum = $|(1\ kg)(30\ m/s)|$
1 diamond, s-momentum = 30 kgm/s
appeared on their displays.

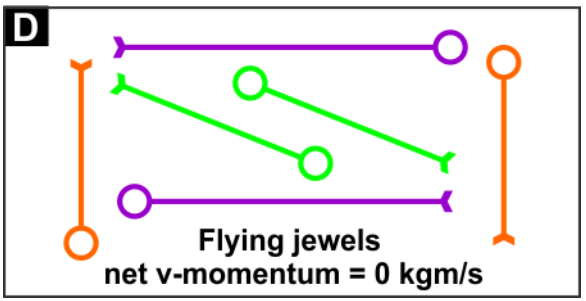
"And to cause that diamond to move," Pico continued, "it must've experienced an impulse [momentum transfer] of:"

$$1\ diamond\ im\Delta\rho = |ms|_{moving} - |ms|_{start}$$
$$1\ diamond\ im\Delta\rho = |(1\ kg)(30\ m/s)| - |(1\ kg)(0\ m/s)|$$
$$\mathbf{1\ diamond\ im\Delta\rho = 30\ kgm/s}$$

appeared on their displays.

"They're the same," Pico summarized. "The last calculation shows that it took an impulse of 30 kgm/s to cause the diamond to travel across the room with an s-momentum of 30 kgm/s."

"Excellent so far," Proge said, as he placed a new vector diagram appeared on the screen. "But how much for the whole room?"



"The omnidirectional r-momentum in a spinning object can cause objects to fly in all sorts of directions," Pico said. "It's possible that a couple of spinning objects tapped the diamonds and caused them to fly around the room at different angles.

"That means the total amount of impulse does not involve direction," Pico breathlessly continued. "Total means total. So, I'll ignore the direction and simply add the speed-momentums. Like this:"

10 diamonds, total s-momentum = 10|ms|
10 diamonds, total s-momentum = 10|(1 kg)(30 m/s)|
10 diamonds, total s-momentum = 300 kgm/s
appeared on their displays.

"And that means to start these diamonds moving in all kinds of directions," Pico continued, "it took this much impulse:"

10 diamonds, im$\Delta\rho$ = $10[|ms|_{moving} - |ms|_{start}]$
10 diamonds, im$\Delta\rho$ = $10\left[\left|(1\ kg)\left(30\frac{m}{s}\right)\right| - \left|(1\ kg)\left(0\frac{m}{s}\right)\right|\right]$
10 diamonds, im$\Delta\rho$ = 300 kgm/s
appeared on their displays.

"Fabulous job!" Proge articulated. "And once again the figures match. Your last calculation shows that it took 300 kgm/s of impulse to cause the 10 diamonds to travel across the room at a combined s-momentum of 300 kgm/s."

"Hi, Pico," Hectii sang out, as her avatar walked into the jewel room. Hectii was actually air-sitting in the middle of the room, near Pico, wearing a 3D visor that was interfaced with Pico's exercise-game. "Explo, this is an amazing room,

Pico. Giant diamonds, rubies, and emeralds flying in all directions."

"Let's jump to the first diamond," Pico said, as she deactivated her data-input gloves, peddled fast, and pressed the jump command. Her avatar jumped to a nearby diamond that was traveling rightward. She glanced around the room and quickly jumped her avatar from diamond, to ruby, to emerald, to diamond, to emerald… until she ran out of gems.

Pico paused to watch the other avatars following behind her.

"Look out!" Hectii shouted as her avatar pointed to Pico's right.

A large red meteoroid was rapidly approaching Pico from the right, and a lavender meteoroid was approaching her from the left.

Pico squealed and hit the jump button. She tried to grab a glass ledge that was suspended in the air, missed, and began falling. "Reset!" Pico yelled.

Instantly all three avatars were sitting on one of the original diamonds, watching the gems glide past in different directions.

"That was close," Pico said breathlessly.

"But we arrived back safely," Proge said, suppressing a laugh.

"And what would've happened to me if I hadn't jumped?" Pico said.

"You would've experienced an impulse," Hectii said, stifling a smirk.

"But how much impulse?" Pico said. "Chip, what was the mass and velocity of the two meteoroids?"

"The red-right meteoroid had a mass of 1 000 kg, a speed of 30 m/s, and a velocity of –30 m/s, because it was traveling leftward," Chip said. "The lavender-left meteoroid also had a mass of 1 000 kg, and a speed of 30 m/s, but it had a velocity of +30 m/s, because it was traveling rightward."

"That seems easy," Pico said. "But should we use the equation for net v-momentum, or the equation for total s-momentum?"

"Why don't you try both?" Proge suggested.

"I'll start with net v-momentum," Pico said, as she activated her data-input gloves and began keying. "The calculations for net v-momentum are:"

$$\textit{net v-momentum} = {}^{\circ}mv_{left} + {}^{\circ}mv_{right}$$

$$\textit{net v-momentum} = (1000kg)(+30\tfrac{m}{s}) + (1000kg)(-30\tfrac{m}{s})$$

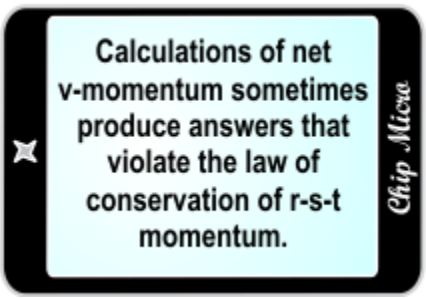
$$\textit{net v-momentum} = (+30\ 000\ kg\tfrac{m}{s}) + (-30\ 000\ kgm/s)$$

net v-momentum = 0 kgm/s

Pico stared at the textbox in amazement, "The net v-momentum is zero! Which means, next time I try this, if the two

meteoroids hit me at the same time, I'll experience an impulse of zero. No effect! The rightward momentum will destroy the leftward momentum and I won't feel a thing!"

Hectii's avatar shook its head. "Pico, your conclusion involves a violation of the conservation fact for r-s-t momentum. Momentum can't be destroyed."



"Ignoring the fact that this is a virtual world," Proge said. "If one meteoroid hits you it will hurt."

"And if two meteoroids hit you from opposite directions at the same time," Hectii said logically, "it's going to hurt a lot."

"You see, Pico," Proge elaborated. "Vector mathematics is very useful. But sometimes vector mathematics produces false or misleading answers. The net v-momentum equation that you used simply tells us, the two meteoroids will come to a stop when they hit you. But the v-momentum equation can't be used to calculate the amount of impulse that you'll experience during the collision."

"In this case," Hectii interpreted, "the answer produced by the net v-momentum equation actually represents a violation of the conservation fact for r-s-t momentum."

"Well, we don't want to violate the conservation facts," Pico said, as she resumed keying. "S-momentum is speed-based, so the total amount of s-momentum in the two meteoroids is:"

$$\textit{total s-momentum} = |ms|_{left} + |ms|_{right}$$

$$\textit{total s-} = \left|(1\,000\ kg)\left(30\,\frac{m}{s}\right)\right| + \left|(1000\ kg)\left(30\,\frac{m}{s}\right)\right|$$

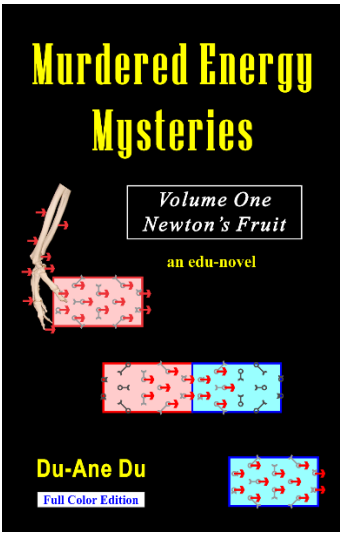
total s-momentum = 60 000 kgm/s

"Ouch!" Pico declared painfully. "We know the two meteoroids will come to a stop when they hit me. This last calculation also tells us, I'll experience a total impulse of 60 000 kgm/s."

"Amazing! We've learned that vector-based calculations of net v-momentum sometimes violate the facts of r-s-t momentum conservation," Hectii concluded. "Thanks, Grandpa Proge."

* * *

CONCLUSION: More research needs to be done into the relationship between mechanical energy and other theoretical forms of energy. Many common beliefs may actually be philosophical myths.



Examine or purchase at Amazon.com

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, see:
Murdered Energy Mysteries,
an edu-novel

Available at: www.Wacky1301SCI.com