



## The Point

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The sun in Boston on a Spring day can be brilliant, the kind the Chamber of Commerce prays for. Perhaps that is why MIT picks this time of year for judging finalists in what can only be described as the Academy Awards of new science. If one believes there really are no new ideas, the concept of “new science” doesn’t quite work out. But the Albemarle Foundation Physics Grant Competition is as close as it gets. The two winners receive funded post-doctoral assignments that virtually assure their research goes to the top of the list in both academia and industry.

Every year hundreds of applications from various disciplines pour in to the MIT Physics Department. The Chair, one tired and bored Aubrey Jenkins, first puts a graduate student to work separating his grad student worldview wheat from the equivalent chaff. Jenkins then culls a handful from the remainder, each of whom are to submit further information prior to being invited. After this the class is winnowed down to no more than a dozen. This year there were only eight survivors. Those that failed to make the cut represented 47 countries, including for the first time Peking University. That poor schmuck was actually lucky. Even if he had found a cure for cancer he probably could not have gotten security clearance to make the trip.

The finalists this year include the usual suspects. Harvard, Yale, Ecole Polytechnique, The Max Planck Institute are all represented. By tradition, actually granted as an amusement to Jenkins’ perverse sense of humor, one unlikely candidate also makes the final cut. This year it is a PhD from Ohio State. Jenkins may, at his whim, give this player a little more time to hang

himself before an orchestrated public humiliation or he may just cut him off at first breath, not even allowing him a chance to speak after having traveled so far.

A young phenom in his growth years, Jenkins has little to show for the last two decades. An early tenure recipient in a school where tenure is rarely granted, he charted a risk-free course to perpetual malaise. Jenkins had become the poster child for the notion that tenure is lifetime employment without the possibility of parole. What might otherwise have been a career of achievement has become one of humankind's unhappiest lives, an all too common byproduct of academia's most cherished prize. His job description long ago morphed from teacher to politician. The only brand of success he can now claim is bringing in the grant for today's event. Like most big school administrators he will say anything for money. Every other year he "teaches" a sparsely attended doctoral seminar during which he reads aloud to the class directly from the textbook. The student rap is that Jenkins has been a has been so long he is a has was. In the real world Jenkins supports the suspicion that a debate about academic arrogance vs. academic impotence makes a distinction without a difference.

Jenkins waits all year for this day. Not only is he allowed to display his power, anoint the favored and distribute largess, it is in public. In the early years of his long decline he was invited to speak at academic conferences. No more. Program chairmen tired of last minute illnesses that just happened to pre-empt his appearance, thus saving him from delivering the talk that he had been invited to give but had not prepared. These medical events always seem to occur only minutes before he was announced, not so amazingly after full payment of all his expenses to the exotic venue where these conferences are always held. There was a rumor that someone had

compiled a list of his conference ailment events and was preparing a research paper titled “On the Dominance of Food Allergies Over Hypertension in Jenkins Conference Escapism”. Either malady was equally likely in the case of the corpulent Jenkins. Having ballooned up in later years, speculation had stopped over whether he exceeded 300 pounds when the Dean commented to a colleague at a faculty meeting “I think Aubrey is topping three bills”. The Dean had made his reputation in Measure Theory. Regardless, his estimation was not in doubt.

Oral presentations, weather permitting, were held in the outdoor amphitheater adjacent to Stata Center, just off Main Street near Kendall square. Frustrating Jenkins’ hunger for publicity, the event had shrunk in size after the initial show ten years ago. Today there would be some graduate students and a handful of junior faculty present in a symbolic kiss of Jenkins’ ring. There would also be a few of the curious, scientist wannabes and others who gravitate toward these kinds of rituals. Finally, the press would be in attendance, although what was a front page local story in the beginning was buried these days somewhere in the campus activities section of the Sunday edition, sometimes a week after the event. Of late it took on the appearance of journalistic filler.

This was unfortunate, as any participant who made it through Jenkins’ sieve had certainly spent the last dozen years of his or her life in the passionate pursuit of an answer to whatever research question they had happened upon as a youngster. Not children anymore, eager to finally have a life – imagine that – which might actually include a paying job, home and family, there was a kind of desperation being played out in each presentation. Of the eight here today six would be sent back to academic purgatory, having been found wanting on the twisted and never

objective Jenkins scale, to languish in some teaching college at wages that barely covered their student loan payments. The truth was that while academia had a justly earned reputation of discovering the obvious and predicting the past, these young people, not yet fully corrupted by educational politics, still represented a bright light. Even if the money would not go far enough to support all of them, trashing their efforts served no one. Except Jenkins.

The presentations had gone per form through the morning. Representative topics included entanglement percolation in quantum networks, conformal invariance in two-dimensional turbulence and Chiral Dirac fermions, not the sort of subjects the average MTV viewer curls up with in front of the fire on a Saturday night. The most dedicated geeks shied away from these questions. With a casual wave reminiscent of the apathetic thumbs up or thumbs down of an overfed patrician watching gladiator fights, Jenkins would either approve or condemn the initial presentation. There were only three approvals to be had in the morning. The first round was single elimination. Dismissal there ended all prospects. The three finalists would have a second bite at the apple in the afternoon session, one going home on his shield.

After only five presentations two had been approved leaving one afternoon slot. All eight had to have at least the morning hearing so Jenkins would bestow the third berth after the last presenter. This unconventional, if not plainly arbitrary, approach deepened the agony for the participants in all directions. Some losers were condemned early while the considerations were still incomplete, remainders held in limbo a little longer. All knew that Jenkins had previewed the applications in the last stages and suspected that he arrived with his mind already made up. A

not-so-subtle twist in the torture was Jenkins' invariant practice to leave the Weak Sister University until last, an atrocity not lost on even the dullest witness.

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The academic and personal history of Jerome Pettersi was anything but a straight line. A certified underachiever in high school, at 22 he limped out of the state college that happened to be the shortest driving distance from his home with a close-call C average. Upon his graduation, the faculty of Average State U breathed a sigh of relief. It was as if an ill-wind had blown in and stayed for four years. In his youth there was a disconnect between what Pettersi thought was important and what his professors did. As an undergraduate, this disconnect resulted not so much in spirited classroom debate between student and teacher as monumental absenteeism. The real world beckoned. When the choice was between working and going to class, the immediacy of financial gain had to be weighed against the ephemeral intellectual remuneration offered by the Ivory Tower. The university rarely prevailed. Pettersi missed upward of 40% of his undergraduate classes.

No less an arena of conflict was Pettersi's personal life. Twice divorced before he was 30, he had mellowed somewhat with age and on this day had lived with one of his ex-wives for nearly 20 years. Alexandra was intelligent as she was strikingly beautiful. Friends could not agree if this woman had the worst luck or the worst judgment of any female in history. No one argued that Alex had qualified for sainthood twice and Pettersi had better be careful. It turned out he was that smart.

Somehow, either in spite of or because of his abrasive and uncompromising nature, Pettersi had enjoyed just enough success in the field that he was barely financially independent. Since it typified his academic, marital and financial history, he sometimes wondered if the word “barely” would be appropriate for his headstone. He discarded that idea, concluding that death is the only part of life you are sure to get right.

Academia fully embraced the political correctness that dominated all of society in the late 20<sup>th</sup> Century. With that came a host of pithy phrases and delicate monikers. Pettersi saw “Returning Student” – the euphemism for an old geezer who goes back to school late in life – as an opportunity. So at the tender age of 45 he applied to graduate school. Incredibly, Average State U admitted Pettersi again, this time to its MBA program. His ex-wife’s forgiveness would have paled by comparison had the target not been the unsuspecting. Apparently, all of Pettersi’s victims from his undergraduate days had retired or did not recognize their old antagonist through the gray hair on their latest Returning Student. More likely, they simply needed the tuition money and were not about to question a paying customer.

Regardless, Pettersi set out to rehabilitate his academic record. Newly a zealot on the subject of book learning, in the next decade he not only never missed a graduate class he was never late for one. Once, the father of one of his professors died. The man had to cancel a class to attend the funeral out of state. Pettersi organized a classroom revolt to demand the hapless soul come in on a Saturday to teach the session that he missed. Pettersi thought that youth was

wasted on the young and so was education. This time around he was out to get all he could from the effort.

Education had progressed little in the 20 years between Pettersi's visits. In fact it had regressed. The salvation of the marginal student is a good memory. Not only had that saved Pettersi in the first round, it now sharpened his recall of his undergraduate days as the identical subjects floated by in his Masters program. Oddly, the same blind dumb luck he had enjoyed in business and women now played out in his academic experience: 20 years later in graduate school they were only teaching what he might have learned had he been paying attention as an undergraduate! The MBA turned out to be remedial. Later, as a doctoral student, when he found himself teaching undergraduates – what goes around comes around – he would observe that his high school curriculum had been socially promoted to the university. This, the result of the academy holding committee meetings instead of teaching, goes a long way toward explaining why Johnny can't read.

Earning respectable graduate marks during his second lap around ASU, Pettersi decided it was time to actually learn something new and set about the search for a serious university to pursue a doctorate. His real world credentials, recent grades he did not have to apologize for and the gray in his beard that no doubt filled some age quota made him a decent prospect for Ohio State. The "If-we-didn't-teach-it-to-you, you-could-not-possibly-know-it" mentality there caused the isolated brush fire but Pettersi's mellowing had progressed just far enough to prevent endless conflagration between him and the OSU faculty. With some effort he found three grownups – not

bad out of four – to serve on a dissertation committee. With his graduation this last time everyone was exhausted but not ready to call it a bad thing.

A lot of highly justified drinking goes on in college and many an ill-conceived dare or bet arises in the course thereof. It is perhaps a shame that Pettersi was not only “returning” but older for certain, if still not yet mature. He just could not stay up late drinking anymore. Thus he was without excuse for sending in his application to the Albemarle Foundation. In a characteristic lack of humility, he concluded that he had something to say and this would be his forum.

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The presentation format was flexible. The podium was equipped with Power Point, USB ports, and Web access, anything necessary to project on the overhead twin screens. Bowing to convention there was also a blackboard behind the speaker. Others had come with impressive graphics, polished simulations and complex formulae, all using the full range of tech wizardry. Pettersi walked up to the platform with his hands in his pockets, from which he withdrew a single piece of chalk. After the usual opening remarks expressing his appreciation, etc. he began “My interest is in a narrow area of mathematical statistics...”

“Just a moment” Jenkins interrupted. It looked like this year the mouse would be blessed by a quick kill. “This is a competition for a Physics Grant, not Mathematics. In Physics we deal with actual things. Mathematics is an abstraction”. A few recognized the undertone of resentment Jenkins held for the criticism his early years as an applied physicist had drawn from the theoretical physicists.

Before Jenkins could wave Pettersi into oblivion Pettersi responded with “Au contraire, would you claim electricity is not in the domain of Physics?” Jenkins, unable to recall the specifics of this bumpkin’s topic and surprised at the quick response, gave a knee jerk reaction “Of course not, how is that even relevant?” Knowing early survival in any contest is key, Pettersi feigned a moment of obsequiousness with “And of course you are correct. Anyone who has received an electric shock knows that there is nothing abstract about that. Yet, electricity can only be described with mathematics. If we agree that there is at least this one intersection between mathematics and physics, I submit that we should be open to other meeting points. 20 minutes from now, using only three lines and a dot I will demonstrate how an abstract mathematical concept has a physical presence in our world.”

Jenkins was not used to being challenged. Nor was he about to be put on the defensive. He knew that if he cut this guy off without a full hearing the story would be across campus before the Albemarle Foundation podium was back in storage. And the story would not make him look good. Sure, it would be forgotten in a few days, but why not give this guy some more rope and fashion a noose. Maybe this year would be more fun than usual. A disinterested “Continue” was heard from somewhere atop the massive frame.

Pettersi stepped to the blackboard and drew a horizontal line almost at the bottom. “Here we have the real number line, the playing field upon which mathematicians wish to describe the universe. It stretches from minus infinity” He put  $-\infty$  at the left end of the line. “To plus infinity” He put  $\infty$  at the right. He then added a curved line above the first one. The second line had a hump and looked like a bell. “Above that line is another line which some claim contains all the

possible observations of life outcomes that can be imagined”. This was pretty basic stuff. A rustling in the crowd hinted that maybe Jenkins’ hook was due. Pettersi then added “Only the naïve believe this, however. This line is of course the famous Bell Curve representing the so-called “normal” distribution. However convenient it may be for the biological sciences, it is useless in most settings for the other sciences. Those using this critter in their research are the terminally safe types, genuflecting to tenure and promotion committees made up of people who haven’t had a new thought since they finished grad school as part of the #2 lead pencil generation.”

This was inflammatory. Jenkins was now irritated. It struck too close to home. Before he could intervene Pettersi was back at the blackboard adding a third line. This time it had a different shaped hump. It rose inside and just above the second one, was narrower in the “shoulders” and its tails stretched far out to each side well above and well beyond the end of the bell curve, very slowly approaching but not quite touching the horizontal line he started with.

“Many have seen a reality more properly shaped like this.” He indicated his third line. “Today we know that the action is in the outside of the distribution of possible outcomes, in the tails. The math for this is rather demanding but it has been worked out for about 20 years. With cheap, fast computing power it is been easy to model this version of reality for about ten years. For five years now anyone has been able to make the required calculations on an internet site.

“Incorporating tail behavior in models removes the blinders. Including those observations that really happen but fall outside the normal curve more closely resembles reality. Enlightened scientists now take this for granted.”

“OK, I am waiting. Your point, Mr. Pettersi?” Jenkins was getting restless. He recalled enough of Pettersi’s proposal to know it went beyond these fundamentals. But he could not recall the punch line. For once he wished that he had paid more attention to the details during his final review. If this developed into a fight, Jenkins was unarmed.

The confrontational Pettersi rose to meet the moment. He stood, looking at Jenkins with disdain, wetting his lower lip in a smile only Jenkins could see that telegraphed “Watch this”.

“Thank you, Professor Jenkins. Here is my point.” Pettersi walked slowly and deliberately to the right side of the blackboard and placed a point in the lower right corner just where the long-tailed third line nearly touched the horizontal line. “It is time to talk about infinity.”

Before Jenkins could interrupt Pettersi again used his name, this time when addressing the audience. “Professor Jenkins is rightly concerned about wandering off into abstractions. Professor Jenkins...” this time there was the inflection of a challenge “...wants physics to be about real things.”

There was a pause that bordered on the dramatic. It fell short enough to keep the atmosphere academic but heightened curiosity just to the point that the least interested in the audience came to full attention.

“So do I, Dr. Jenkins. So do I.

“The study of tail behavior leads to insights about infinity. Some of these are pretty radical. Some are just too startling to discuss among inbreeds saluting the dominant paradigm. Some proclaim loudly that the Emperor has no clothes on.

“For instance. Consider the mathematical concept of the limit. The limit is a place of not quite. You almost get there but you don't. You merely ‘approach the limit’ or ‘tend to the limit’. Terribly abstract and not very satisfying for those who want physics to be about real things.”

Again Pettersi approached the lower right corner of the blackboard, indicating the point he had placed there, the spot where the two lines nearly came together. “The fancy word we academics give what we see on the blackboard here is ‘asymptotic’, a line that gets arbitrarily close to but does not touch another line.

“Now a blackboard does not serve us well. In theory a line has no width and a point no dimension at all. Here I need you to suspend your disbelief, put aside years of programming and just ‘go with me’ for the moment.”

Jenkins was not about to go willingly. “Is this to be a first year Bonehead Math 101 lecture? Why are you dragging us through all this uninspired drivel?” he roared.

“Because it’s wrong” Pettersi was careful not to say “Because you are wrong”, knowing that his time on the podium could be terminated at any moment. Everyone knew that Jenkins and all the rest of the attendees completely believed in the uninspired drivel – they had all been required to regurgitate it repeatedly throughout their academic lives. It had been around a long time and lay at the base of everything else they knew. Academia worships the security of the large numbers in the big, central part of the distribution where predictions could be safely if not accurately made. Their chief co-conspirator, indeed their prime enabler, was the bell curve, the cozy assumption that everything was normal. Academia could not operate without this fiction. Surely the earth would open up and swallow Pettersi for his blasphemy.

Pettersi just ignored Jenkins’ growing indignation. It was time to drop some names to keep his hold on both the dais and the audience. He continued, “Fifty years ago Feynman exhorted your intellectual forebears to take miniaturization as far as possible and today we have nanotechnology. Thirty years before that Heisenberg convinced us that uncertainty was unavoidable.

“What if that is not so?”

“What if infinity...” Pettersi banged on the blackboard near the Point “...is actually the point that represents the last observation? What if infinity is where the infinitely small space

between the lines is filled by the dimensionless point? What if infinity is where expectation meets realization? What would that mean?"

The audience was silent. No one wanted a part of this. Jenkins, viewing as heresy anything he had not learned in graduate school, decided it was time to put an end to it. "OK, OK, we know all about Heisenberg and Feynman. We really would like to move on, Mr. Pettersi. If you don't have anything to say about this century or this planet perhaps we can gavel this meeting to a close. I need to get home. I am sure you have some place to go. Isn't Star Trek on tonight?"

Pettersi did not yield. It was clear that he would not go meekly. Jenkins was not used to this. He was accustomed to having his victims slink off with their tail tucked just where he wanted it. Pettersi gave him a look that said "Back off". A threat? Jenkins wondered if this is what the real world was like. Could matters get rough here? Jenkins wanted Physics to be physical but his interest in real things was limited to the abstract. This was not normal. It hinted at becoming more than Jenkins had bargained for.

Gently but firmly Pettersi said. "I am nearly finished". He did not ask for permission, he did not hesitate, he just went on.

"I claim that infinity is the point where what might happen MUST happen. It is the last observation, farthest out in the tail, the most unlikely, the rarest. As such, it is the place where uncertainty is finally resolved."

“But Mr. Pettersi...” Jenkins started with an air of exasperation.

Pettersi was ready for him. “I know. You want a testable hypothesis.” This was the part Pettersi was least sure of. In the last ten years he had imagined enough details of this theory that he thought it captured at least part of the world he had lived in for most of his 56 years. But they had been fleeting glimpses. The life that delivered him to this moment had been a sequence of rare events spaced widely apart. Alex was Exhibit A. Getting her back was like winning the lottery a second time. There were a few other times that he had tipped the narrowest odds in his favor. At all times his fingerprints could be found prominently embossed on the tiller of his existence. Chance had been neither his sovereign nor his subject. All he knew for sure was that randomness and determinism had made peace within his experience and had deposited him here.

What he knew was that today was his last day in academia regardless. Either he went down in flames with this argument or he won in a way that left him outside the club. This was of no concern. His personal experiment was complete. After today there was nothing left he wanted to say or prove. Anyway, given his real world capabilities, putting a dead-end job on the pass line was not exactly the biggest gamble he had ever made. Academia could have the center of the distribution, the domain of the mediocre. He had started life in the extreme regions and found in them a home. Life in the tails was exciting at any age. Pettersi was once again returning. This time to a place where one was rewarded for thinking outside the box that academia had built to live in.

Jenkins saw the opportunity to continue the circus to his advantage. Science progresses by empirical reasoning, examining a large number of cases and inferring The Truth from the numbers. Among the brethren it is called “Going from the Many to the One”. This guy had painted himself into a corner by admitting that his entire theory was based on one data point. How was this upstart going to bail himself out? Jenkins pounced “Proof is in the empirics, as they say. How do you propose to make a case with a single observation?”

Pettersi was standing between Jenkins and the audience, facing neither. With a sideways glance in either direction he could see one or the other. Behind him, where he could not see, was Main Street. “If you look behind me you see three vehicles moving along Main Street right now. When I finish this sentence they will stop, travel backwards 50 feet and then continue on their way.” Pettersi did not move. He was the only one. All eyes turned to Main Street to watch three cars in motion pause briefly, back up a little more than two car lengths and then resume their eastward movement.

Scientists are rarely surprised. They work methodically, even ponderously, inching their way toward a goal. Preliminary signals of the final outcome are given along the way. Whether this is a convention handed them through the centuries by their predecessors or a device to reinforce low expectations one cannot say. This demonstration took most of the audience by surprise. If academics *could* utter an audible gasp this would be the time they would.

Jenkins had to think fast. He was losing control of the event. This clown was upstaging him. It had to be a trick. Illusions are created every day with digital editing and rear screen

projection. To pull this off Pettersi had only to hire three students and equip them with receivers for his hidden wireless microphone. Keeping the street clear of other cars would represent a logistical difficulty but not exactly Mission Impossible. It was time to put an end to this smoke and mirror show.

“Well, Mr. Pettersi, I don’t know how you did that, but it was entertaining. What it has to do with Physics I am sure is lost on me. No doubt there are courses in prestidigitation at Ohio State and I’ll bet you excelled in all of them. Perhaps before you go you would like to make the Statue of Liberty disappear.”

Pettersi ignored the sarcasm. “I’ll do better than that. In a moment I will provide one last bit of evidence that will leave at least one person here convinced. That person will be you.”

To a dismissive shake of his head, Jenkins added a smirk.

“Before I do that, I need to make one thing clear. As sure as I am of the theory, I am less sure that I am able to explain it.” Pettersi turned fully toward the audience. “I leave that to you.

“A single event occurring at infinity is so unlikely it cannot be imagined. Yet it must come to pass. That contradiction is not lost on me. Rather, I embrace it. I hope I have sparked enough interest here that some promising newcomer will carry on the search. My part is done. The edge of the abyss is for the younger man. It is time for me to back away from the cliff. A powerful force makes my claim compelling. It is the nature of man to strive in the direction of

the impossible. Its rare achievement is what propels man forward. Without rare events in the past we would not be here today. Yet we must be here as surely as infinity must exist in order for the Universe to function.”

He turned to Jenkins. By now no one knew what to expect. Even Jenkins wasn't sure how this would play out, only that he wasn't going to be a part of it. Pettersi anticipated this.

“Professor Jenkins, my guess is that right now you are the least inclined to assist me in my quest, not one bit willing to join me as an accomplice.” About this no one was in doubt. The crowd knew enough about Jenkins to know that if he could repeal gravity to undo Pettersi right now he would do it.

“Professor Jenkins, that is precisely the position I need you to take. In fact, I would like you to mentally reinforce it by promising yourself that whatever happens in the next few seconds you will do nothing to support my argument. I am sure I can count on you for this. Thus, we should be able to agree that if you indeed DO assist me, that act will be the rarest of events. If my theory is true we shall visit infinity together as you help me here today.”

Jenkins listened implacably, wishing the ordeal to be over. Even if this guy could arrange traffic patterns, nothing he did was about to involve him. His giant frame nestled deeper into his plush Chairman's perch. He waited for what he hoped would be the final, forgettable moment to this sideshow.

“My request is a simple one, Professor Jenkins.” Pettersi continued calmly. “All I ask is that you stand up. Please rise from your chair for a moment and then sit down again.”

The crowd was disappointed. Not only was this not going to happen – it was like asking Jenkins to run out and fetch him a cup of coffee – it really was not as spectacular as they thought a carnival act required. Couldn't he turn Jenkins into a frog? That would have multiple benefits.

Then, with no expression to give away any emotion but with the effort required to launch a large mass of flesh, gravity was overcome as Jenkins stood up. This time the gasp of the audience *was* audible.

“Thank you, Professor Jenkins. That is all I need.”

Jenkins sat back down. He had no sensation of any kind. No out of body experience, no feeling of hypnosis, no lightness, no darkness, nothing that could be called occult. He could not understand his most recent action. He did acknowledge one emotion: empathy. When Pettersi had said he was unable to explain a rare event, Jenkins knew what that meant. Next a feeling Jenkins had not had in decades was rekindled. He was curious. He was interested. He wanted to know more about what had just transpired. He felt alive.

Pettersi thanked the audience for its attention and walked from the stage.

The crowd was a little stunned, not sure what they had just seen. Then a remarkable thing happened. Jenkins stood again. Slowly, very slowly to indicate just how careful he wanted to be in granting approval, he began to clap. One clap. Pause, a second clap. A third. The crowd, having been authorized, joined in. Some wondered if Jenkins was serious or if he wanted to defy the single-event theory by displaying a second rare action. But it could not be in the same class of observations. This time the movement was voluntary. The rare event this time was not in the same sample space as the first.

After the obligatory end-of-morning remarks, which included a mysterious bequest of the last afternoon slot either to Jerome Pettersi or whoever would take up the cause Mr. Pettersi had just professed to be finished with, the crowd began to disperse for lunch. The morning was at an end but it was clear that the idea would persist well beyond the afternoon. Walking away, the contestant from the Netherlands was overheard asking another participant “If Pettersi had put the point on the far left side of the blackboard, would Jenkins have momentarily weighed minus 300 pounds?”

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