Greetings from MIT
to our Alumni, Faculty, Staff, Parents and Friends!

1) The MIT Hillel Program Staff accepting the The Phillip H. and Susan Rudd Cohen Outstanding Campus Award

2) Keep an eye on your inbox and mailbox for the final version of the picture Charlotte Minsky '20, Elisheva Shuter '18, and Jonathan Hurwitz '18 exploring Chanukah and eclipse themes for our cards and greetings

3) MIT’s Challah for Hunger group baking for DIY Shabbat

MIT Hillel Update

Thank you!! That’s not necessarily the column beginning one might expect immediately pre-Chanukah (perhaps: “Happy Chanukah”), or as students enter exam period (“Good luck”), or as the winter “giving season” begins (“Please support us!”). And, yet, it is the most appropriate.

My program staff and I spent the last week in Denver at Hillel International’s Global Assembly, learning with, networking with, and visioning with 1000+ colleagues from across the world. The energy was exhilarating. The week started on a high that only got higher – and I’m not just talking about Denver being the mile-high city. At the opening awards ceremony, MIT Hillel was honored with the Phillip H. and Susan Rudd Cohen Outstanding Campus Award as one of the two top Hillels in the movement. The award recognized us as having exceeded measurement benchmarks – based on quantitative data about our students – in breadth, depth, and impact on our student engagement. Please enjoy this 3-minute video that was created about MIT Hillel that briefly highlights our successes, through student and staff stories. Our success on campus is all of our success: thank you to my staff, to our students, to all MIT partners for helping us reach this milestone. And thank you to each of you stakeholders for being a part of our work, caring for our students, maintaining active interest in all we do.

The conference ended on a personal and professional high for me, too. I had been asked to do a TED-style Hillel talk for the gathered professional staff, and stood before my colleagues at the closing plenary to emphasize the need for self-care, and particularly that self-care is a team endeavor that we’re all in together. Once the video of the talk is forwarded to me, I will share it with all of you. It was an honor to stand before my peers: encourage them, elevate my staff team who have been and continue to be my support network, and share some of my wisdom with the field.

Back on campus... it’s Chanukah! Over the eight nights of the holiday we have multiple “Do It Yourself” Chanukah parties being organized by students for students in dorms, in fraternities, within departments, within programs like Concourse, and within many other sub-communities around campus. This Thursday is our annual Test Tube Menorah lighting (5:00 PM, Student Center), with a laike “tapping bar.” We’re happy our students get to relax and celebrate as they also enter into the season of final papers and exams.

May we all have much light shine upon us, and bring much light to all pockets of darkness, this Chanukah! May we go from these moments of celebration to much more brightness.

Happy Chanukah,
Rabbi Michelle Fisher SM ’97, Executive Director, MIT Hillel
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Torah from Tech

Our Torah this month is taught by Alex Klotz, a Post Doctoral Fellow at MIT. His research interests include the physics of DNA molecules, collapsing bubbles, and falling through the Earth. He can be reached at aklotz@mit.edu. The full article can be found on his blog.

Every November or December, Jews around the world celebrate Hanukkah, a holiday that commemorates defeating and driving out the Hellenistic Seleucids from Israel and establishing the short-lived Hasmonaon kingdom* around the year 160 BCE. The celebration of Hanukkah involves lighting candles, eating greezy food, exchanging gifts, re-telling the story, and playing games with a spinning dreidel.

A glance at what was going on in December of 1982 at MIT Hillel!
Legend has it that when the study of Judaism was banned by the Seleucids, scholars took to the hills to study in secret, and when authorities came to investigate, they pretended they were just doing some good wholesome gambling. That legend, however, is very likely made up and doesn’t appear in print before 1890. I read an article arguing that the dreidel originated from a popular gambling device called a teetotum that was popular in Northern Europe in the medieval period, that eventually made its way into Yiddish culture. The letters on the four sides of the dreidel (equivalent to N, G, H Sb) are interpreted to stand for the Hebrew “Nes Gadol Haya Sham” (a great miracle happened there), but originally stood for the Yiddish rules for gambling with a dreidel: nit (nothing), gants (everything) halb (half), and shtel ein (put one in)**.

From a physics perspective, a dreidel is an example of a spinning top, a source of extremely difficult homework problems in undergraduate classical mechanics related to torque and angular momentum and rigid body motion and whatnot. I was chatting with a theorist I know who mentioned that it would be fun to calculate some of these spinning-top phenomena for the dreidel’s specific geometry (essentially a square prism with a hyperboloid or paraboloid base), and I suggested trying to compare it to high-speed footage. A quick literature review revealed that most of the dreidel analysis has to do with whether the gambling game is fair and how long the games last. Annoyingly, the search was obfuscated by the fact that there’s a publisher called DReidel.

My lab has a high-speed camera that is used to film gel particles and droplets as they deform. It is normally connected to a microscope, but with the help of a student in my lab, we removed it and connected it to a macroscopic lens we had lying around in ye-olde-drawer-of-optics-crappe. A representative of MIT Hillel graciously provided me with a few dreidels, and I some time spinning the dreidels in front of the high-speed camera and recording them at 1000 frames per second.

Before I get into the more quantitative analysis, let’s just take a look at what a dreidel looks like in slow motion, because as far as I can tell from a the google, I am the first person to attempt this.

As I initially spin the dreidel, it spins in the air a few times, lands with an axial tilt, and gradually rights itself as its angle of precession comes closer to the vertical. After that, you can see it spinning rapidly and precessing a little bit, but not doing anything too crazy.

The self-righting behaviour is a lot more extreme when I do the advanced-level upside-down flip.

On those first few bounces, it really looks like it’s going to fly out of control and crash, but still it gradually rights itself into a stable rotation. While this self-righting tendency is strong...it is not unstoppable.
It's also pretty fun to watch what happens when they eventually lose stability and fall over.

This self-righting is too complicated-looking for me to understand right now, so let's look at something simpler: the steady-state (a) rotation and (b) precession.

To perform quantitative analysis of the dreidel's motion, I would want to be able the measure the phase of its rotation over time. Because the dreidel is made of reflective plastic, as it spins it reflects light into the camera, moreso when its face is parallel to the plane of the camera. Thus by measuring the total intensity, we should have a proxy for the phase of the dreidel, each intensity peak being a quarter-turn, and can investigate how that evolves over time. I wrote a MATLAB script that summed the total intensity of each frame and plot it over time.

There was initially a problem with this method of analysis, however. You can figure it out if look at the wall behind the dreidel in the above gifs (especially the wide crashing one), and notice that it's flickering. This is because the room is illuminated with AC electric light with a 60 Hz frequency. The light intensity is proportional to the square of the current, so it has a maximum twice per cycle, and the light flickers at 120 Hz. That is exactly the frequency at which the intensity fluctuates; the flickering was swamping the contribution from the dreidel. However, the quarter-turn frequency isn't that far off, so I was getting some neat beat frequency dynamics as well***.

This caught me off guard and it was skewing all my videos, so I took another few recordings using my cell phone flashlight with all the AC lights turned off. The videos don't look nearly as good, but the time-series are cleaner.

We can the intensity fluctuating periodically every ~8 ms, corresponding to a rotation period of 32 ms (nicely close to the square root of 1000, so it's also around 32 rotations per second), and a slower mode of about 200 ms or 5 precessions per second. 32 rotations per seconds is 128 quarter-rotations per second, so you can figure out why it took me a while to figure out that I had to disentangle it from the 120 Hz light flickering.

The fourier transform shows two peaks, one corresponding to rotation and one to precession, which is of stronger amplitude (I believe this is due to my analysis method and not to actual physics). The reason the peaks are smeared and not as at a sharp frequency is because the angular velocity gradually decreases as the dreidel loses energy to friction, so the peaks get smeared to the right.
With the flickering out of the way, I can also calculate how the rotation period evolves over time, using a peak-finding function in MATLAB. It gradually gets slower, as expected, which 6-7 ms between peaks at the beginning, and 14 ms between the peaks before it crashes. If this is caused by dry friction at the base, we would expect the frequency to decrease linearly with time. If it’s caused by viscous drag, we would expect an exponential decrease. What do we see? The fact that it’s discretized by the frame rate makes it harder to tell, but applying a rolling average on the frequency decrease suggests that it is linear and thus caused by dry friction.

That was mostly a discussion of the rotation, although precession presented itself as well. Let’s take a closer look the precession. I wanted to measure the angle the dreidel was at with respect to the vertical, and how that evolved over time. This is not as easy to measure as the total image intensity; I had to use Principal Components Analysis. I found an algorithm on this blog post, and it worked as follows:

1. Define a threshold intensity such that everything in the image above the threshold is dreidel, and everything below it is background. Set the dreidel equal to 1 and the background equal to 0.
2. Define two arrays, one containing all the x-coordinates of all the 1’s, and the other containing all the y-coordinates of all the 1’s (such that each 1-pixel is represented in the array).
3. Calculate the 2x2 covariance matrix of the location array.
4. Find the eigenvectors and eigenvalues of the covariance matrix.
5. Find the angle associated with the eigenvector with the larger eigenvalue (e.g. the arctangent of the ratio of its components)

With some finagling to get the angle in the correct quadrant (I wanted the angle from the vertical, not from the horizontal), this works pretty robustly. It works better if I crop the movie to only include the stem. This actually only measures the angle of the dreidel projected onto the plane of the camera and doesn’t provide information about its tilt towards or away from the camera, but it’s good enough to see how the precession angle evolves. I can examine how the angle evolves over time...and it’s pretty neat.

Two things are apparent from looking at this graph: both the amplitude and frequency of precession are increasing over time. The Fourier spectrum of the precession angle contains only the precession peak, without the rotation peak at higher frequency. What’s happening is that gravity is exerting a torque on the dreidel at an angle relative to its principal angular momentum vector, which induces a precession in the direction determined by the cross product of spin and down. The angular frequency of precession is inversely proportional to that of rotation, so that as the dreidel slows due to friction, its precession speeds up, which is what we see. The spinning is essentially preventing the gravitational torque from pulling the dreidel down, and as it loses angular velocity, the precession angle gradually increases.
This whole project started as a discussion with a colleague about how the term "Jewish physics" should be repurposed from a label the Nazis used to discredit Einstein, and dreidels seemed like a natural thing to focus on. After fiddling around with a high-speed camera for a bit I got some cool videos, and thought it was neat.

In addition to being a fun little diversion, it also spurred an improvement in my DNA image analysis code. It was taking so long to open the dreidel movies in MATLAB that I looked into a more efficient way of doing so, which improved loading time by like a factor of 20 (from 55 seconds down to 3 seconds), which I now use to open DNA movies as well.

"If you grew up hearing the Hanukkah story every year, you probably will not recognize the words Hellenistic, Seleucid, or Hasmonean.

**For those unfamiliar with Jewish linguistics, Hebrew is a Semitic language related to Arabic and Ethiopian (Amharic), whereas Yiddish is a Germanic language that uses Hebrew letters, so some of the words are similar to the also-Germanic English, e.g. halb and half.

***This is what the FAKE NEWS wrong analysis looks like:

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MIT Hillel's 2018 Annual Fund
Add to Jewish life @ MIT!

To Our Current and Future Supporters,

"It’s all about managing the transitions". These words were spoken by the contractor who renovated my current house as well as my previous condo. He was talking about how materials abut in ways both small (how the tile pattern ends) and large (how to find the source of the roof leaking around the chimney). That simple phrase has become my guiding mantra for planning and living daily life.

Managing the transitions applies broadly to the work generally of MIT Hillel. From welcoming incoming freshmen to celebrating each year’s graduates and reunion alumni, from regular Jewish observance to less even steps on students’ Jewish journeys during these formative years, from supporting students through personal crises and celebrating their individual and group successes – MIT Hillel helps students manage a variety of transitions during their time on campus.

And, as I write this, I am applying the catchphrase to work, as we ready ourselves to wish Ben Flax well on his next career phase at the Museum of Science. Ben came to MIT Hillel three years ago, fresh out of college. During his tenure here he grew the job in many ways, and has been an invaluable source of support to me in development. Ben updated your record in the alumni database, processed your gift, and prepared your thank-you note. He warmly welcomed you to Leading Jewish Minds and made sure every event detail was in place. He prepared and disseminated many of our donor communications – Rabbi Fisher’s monthly e-newsletter, invitations, social media, website. And supporting me was only one-quarter of his overall job description! In addition to being organized and dedicated, Ben has been fun to work with and brought a community-building warmth to this administrative role. Please join me in thanking Ben for his work at MIT Hillel, and in wishing him well at this turning point.

And, Happy Chanukah!

Marla Choslovsky SM ’88,
MIT Hillel Director of Development
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Add your name to MIT Hillel's 2018 Donor Roll!

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Tamid Initiative - Planned Giving @ MIT Hillel

We invite alumni and friends who care deeply about Jewish life at MIT to consider joining the Institute's Katharine Dexter McCormick (1984) Society (KOMS) and be part of the Tamid Initiative by making a bequest to MIT, for the benefit of MIT Hillel. Your generosity will help MIT Hillel engage today’s students, securing our Jewish future with confidence.
On the Calendar

Boston:
- February 2 – Bob Weinberg on "Where Are We in the War on Cancer?"
- March 23 – Beth Klerman
- April 27 – Peter Temin

Mazal Tov!

- Mazel Tov to Rabbi Lev Merowitz Nelson, past rabbinic intern at MIT Hillel, on being awarded the 2017 Covenant Foundation Pomegranate Prize, which is awarded to those making a difference in the field of Jewish education.

If you have life-cycle events to share with the MIT Hillel community, please let us know.