Magnet Madness Revisited

Tom Mahood
Calif. State University, Fullerton
December 7, 1999

This is a follow-up to the experiments described in detail in “Falling Magnets of Autumn” dated November 18, 1999, as I clearly don’t know when to leave well enough alone. Those experiments showed there were no large anomalous behaviors in free-falling magnets. However appeared to be some interaction between the magnets and the electromagnetic release, which skewed the data in certain ways. Specifically, the magnets in certain orientations would reinforce or interfere with the magnetic grip of the release mechanism, and the magnets would fall away at slightly differing speeds. While the purpose of the experimentation was met (no strange behavior was found), the mucking up of the data was quite annoying.

After the conclusion of the initial experimentation, some additional magnets became available. These were 1” diameter, Neodymium discs, 0.187” thick. They were Grade 27, which refers to their maximum energy product being 27.0 Mega Gauss-Oersteds, and had a residual induction Gauss rating of 10,800 Gauss. Putting aside the technical ratings, these were just plain scary-powerful magnets, and care had to be taken to keep one’s fingers from between them. They proved to be far stronger than any other magnets investigated prior. These new magnets provided a good excuse to re-do portions of the initial experiment, and take measures to eliminate the interaction with the release.

A new carrier was fabricated for two disc magnets out of acrylic. The magnets are contained in a portion of acrylic tube approximately 1.25” OD and 1.85” tall, in a horizontal orientation. Extending from the top center is a 9” long piece of 0.312” diameter acrylic rod. At the top end of the rod is a small steel screw with a machined flat head. The screw provides an attach point to the electromagnetic release, and the rod keeps the magnets far enough away to prevent their undo influence on the release. The total mass of the carrier and magnets is 90.15 grams, and the magnets alone are 36.05 grams.

The drop structure consisted of the same 4” ABS sewer pipe special, which had previously worked well. However, the new magnet carrier is much longer than previous units, and the drop structure as initially constructed wasn’t tall enough. As a result, the structure had to be slightly re-worked to accommodate the longer carrier by lengthening the top.

The plan was to be even more rigorous in data collection this time, and for each series of tests the magnets orientation was carefully noted (i.e., N or S). For each sequence, 20 drops were performed.

The following is a summary tabulation of the testing, mercifully omitting the raw data. Two drop series were made with like faces opposing (and differing faces up) and two drop series were made with opposite faces opposing. Finally, drops were made with the magnets replaced with dummy weights selected to equal the mass of the magnets which would act as a baseline for comparison. Count timing was as before, with 491524 counts occurring in one second.

1" dia. Neos	**N to S**	**N to S**	**S to S**	**N to N**	**Dummy**
	N face up	**S face up**	**N face up**	**S face up**	**Weights**
Average Count (20 drops)	**249883**	**249788**	**249845**	**249819**	**249769**
Std Dev of Count	**84**	**75**	**62**	**38**	**69**
Count diff. from dummy	**114**	**19**	**76**	**50**	**0**
% diff from dummy	**0.0455%**	**0.0074%**	**0.0303%**	**0.0199%**	**0.0000%**

As may be seen from the data, the spread of individual tests is fairly tight, with low standard deviations. All the magnet tests are very close in value to that of the dummy weights, with the maximum difference being only 0.0455%. However, careful examination of the data shows something a bit odd. All of the tests involving magnets produced counts greater than the test of the dummy weights (i.e., they fell slower). This was both unexpected and annoying.

Since the anomaly appeared with the tests involving magnets, the obvious culprit is the creation of eddy currents in surrounding conductors, acting to oppose the fall of the magnets. When the drop structure was modified as mentioned, three aluminum stabilizing struts were added to increase its overall rigidity. These struts were attached to the 4” ABS tube with a stainless steel ring clamp. Also, there were two sets of wires running along the side of the ABS tube, providing power to the lasers and picking up the trip signals from the IR detectors. Perhaps the totality of these masses of metal could combine to produce enough eddy currents to create the very small differences noted. So, the drop structure was altered, removing all adjacent conductors to the extent possible. The wiring was moved further out from the centerline of the tube.

Since the drop structure had been “messed with”, another baseline of 20 drops of the dummy weights was performed. It was in very close agreement with the earlier test. Next, a set of magnets with N and S faces in contact, with a N face up was tested. The spread of the data improved from early testing, but it was still a larger count than the dummy weight baseline. A similar situation was observed when the magnets were dropped with similar faces in contact (S to S) and a N face up. A fourth test was begun with the magnets placed with N face to S face and a S face up. However after 9 drops, very erratic readings began which indicated one of the trip lasers had got out of alignment. Since adjusting it would likely slightly change any new data, it was decided to end the experiment at that point and utilize the data acquired to date.

1" dia. Neos	Dummy	N to S	S to S	N to S
	Weights	N face up	N face up	S face up
Average Count (of 20)	249772	249846	249834	249767
Std Dev of Count	29	53	43	21
Count diff. from dummy	0	74	62	-5
% diff from dummy	0.0000%	0.0296%	0.0247%	-0.0019%

These additional experiments produced a most peculiar and unexpected set of data. The stinkin' magnets were still falling slower! There also seemed a slight tendency for configurations with the N face up to fall more slowly.

While it's always annoying when reality refuses to conform to my wishes, the possibility that falling magnets fall slower is, to put it charitably, remote. Are there possibilities other than eddy currents? One certainly is that the field from these considerably more powerful magnets is able to reach out and still slightly affect the electromagnetic release. This could explain the apparent tendency for configurations with the N face up to fall slower. However the bottom face of the electromagnet is N, so if anything, the field would act to repel the electromagnet and it should fall faster.

The likely suspect is the design of the carrier itself. Recall that it is essentially a short cylinder (containing the magnets), from which a long, thin rod extends. When the carrier is released and begins its fall, it becomes weightless. At that point, the magnets will try to align themselves with the lines of the Earth's magnetic field, which dips at roughly 45 degrees at our locale. As it does so, the carrier will tilt from the vertical, and the trailing rod will tilt into the airflow. This will result in a small, but discernable, increase in drag. This behavior was observed by dropping the carrier from the ceiling, outside of its tube. It could be seen to slightly tilt from the vertical as it dropped. The slight differences between the N face up orientation and that of a S face up could be its reaction to the specific magnetic dip.

In summary, there still does not appear to be any differences in free-fall characteristics between magnets and dummy weights to at least one part in several thousand, even with extremely powerful magnets. While very small, apparently anomalous results were obtained, it appears they are the result of relatively mundane effects and the world is still a safe place for democracy. Hopefully, this will conclude all future magnet dropping activities on my part, as I've now joined Magnet Dropper Anonymous.

"Just say NO to Magnet Dropping"