

Deducting Dimensions

NOVA Activity **The Elegant Universe**

You experience daily life in three spatial dimensions (and one dimension of time). You move forward and backward, step left and right, and go up and down stairs as you move around your world. But string theory requires that you live in a world with an additional six or seven spatial dimensions. Without these extra dimensions, the equations in string theory don't make sense. But even physicists who think about these extra dimensions every day have a hard time picturing them. One way they improve their mental picturing ability is to work backward and imagine a world with *fewer* than three dimensions. See if you can imagine a universe with only one, and then two, dimensions.

Procedure

- ① To the right is a set of questions for each universe to get you started. See if you and your team members can answer the questions first for a one-dimensional universe and then for a two-dimensional universe.
- ② As you explore each universe, try to imagine what life would be like in that universe.

One-Dimensional Universe

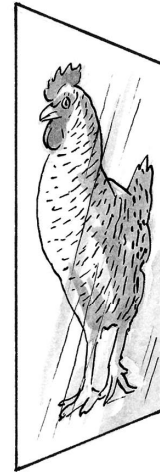
This universe is like a line with no ends. It has no up and down or left and right, only a forward and backward that go on forever. Remember that it is not like a wire stretched across a room within a three-dimensional space. There is no outside room; wire is all there is, just forward and backward.

Two-Dimensional Universe

This universe is like a flat sheet of paper that goes on forever. Unlike the wire, this universe has a forward and backward and a left and right. What this universe does *not* have is an up and down.



3-D Chicken



2-D Chicken



1-D Chicken

Questions for each universe:

- What is the shape of a creature that inhabits the universe?
- How would one creature appear to another? If the creatures are able to move around one another, how would they appear to one another if they were lines? If they were rectangles? If they were circles?
- What path would a creature take as it moved?
- How could creatures communicate?
- What kind of social structures might exist?

Questions

Write your answers on a separate sheet of paper.

- ① How many creatures can a given creature communicate directly with in each universe, assuming that they must be in nearly direct contact with one another to do so?
- ② Suppose a message needs to be passed to 64 creatures. Assuming that one creature can only communicate with one other creature at a time and that each message takes one minute to transmit, what is the shortest amount of time that a message could be passed in a one-dimensional world? How would the transmission occur? What about in a two-dimensional world?