

Suppose you don't know anything about  $D \subset \mathbb{R}^2$ , but I tell you that there is a vector field  $\mathbf{F} = \langle P, Q \rangle$  with  $Q_x - P_y = 0$ , but which is not conservative.

What can you say about  $D$ ?

- (a) It must be all of  $\mathbb{R}^2$ .
- (b) It must be simply connected.
- (c) It must **not** be simply connected.
- (d) It must be bounded.
- (e) I can't say anything.

## The underlying math:

The more holes that  $D$  has, the more different vector fields  $\mathbf{F}$  we can find which are not conservative but still satisfy  $Q_x - P_y = 0$ .

So “counting” these vector fields tells us how many holes are in  $D$ .

Going up one dimension, look at  $D \subset \mathbb{R}^3$ :

- We count vector fields which are **irrotational** ( $\text{curl}\mathbf{F} = 0$ ) but **not conservative**.

This tells us how many “one-dimensional holes” are in the solid  $D$ .

- We also count vector fields which are **incompressible** ( $\text{div}\mathbf{F} = 0$ ) but **not irrotational**.

This tells us how many “two-dimensional holes” are in the solid  $D$ .

This is called studying the **cohomology** of the space  $D$ , and is a technique used in **topology**.

# Announcements

- Final exam is this Friday.
  - Locations have been posted on the final exam webpage. Please read carefully, as they are different from the previous assignments.
- Grades on Moodle.
  - I will try to upload all i-clicker scores (as well as excused absences) this week, or over the weekend. **I will post an announcement on the course webpage once I have done so.** If you see this announcement, but you think one of your grades is missing or wrong, please email me as soon as possible. If you don't see the announcement, hold tight.

## More announcements

- Office hours/review session this week:
  - Extra office hours Wednesday evening (5–7pm—it's fine with me if you bring your dinner). **AH 443**
  - Extra office hours Thursday 12–12:50pm. **AH 314**
  - Also office hours on Friday 9:30–10:30am. **AH 341**
  - Come with questions (or you can listen to other people's questions). You can also post questions in advance on Piazza (there's a folder called "questions-for-review-sessions" or something like that).
  - Please bring your i-clicker.
  - You can bring food. Don't bring nuts, peanuts, or fish. Do clean up after yourself.
- TA help room—AH 147.
  - Wednesday: 4–8pm.
  - Thursday: 12–8pm. (AH 445 and 447)
  - Friday: 11am–3pm. (AH 445 and 447)

Please change your selection to describe your feelings about the problem as we go.

- (a) I'm following.
- (b) Wait, I got lost on that step!
- (c) That sort of made sense, can you explain it again?
- (d) I don't understand, but your explanations aren't helping right now, so I think you should move on. I understand that this means that I should try to figure this out after class. I understand that there are resources available to me, such as
  - reading the textbook, looking through lecture notes and old worksheets
  - coming to office hours (Wednesday! Thursday! Friday!)
  - coming to the TA help room (Wednesday! Thursday! Friday!)
  - asking a friend
  - asking on Piazza

I understand that if I don't take responsibility for my learning, and a similar problem shows up on the final, I may regret my inaction.

If you're not paying attention, don't bother clicking any buttons.