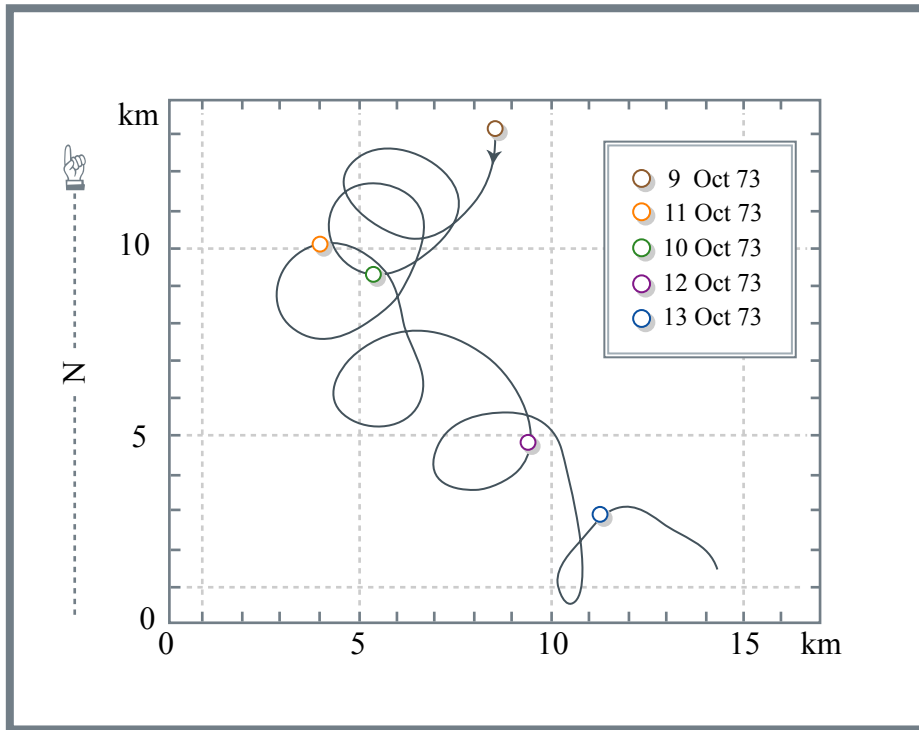


**12.800: F04 Problem set 7**

1) The equipotential surface of a disk rotating at a rate  $\Omega$  takes on a parabolic shape (think the free surface of a tank of water in solid body rotation). Derive the equation for this parabola ( $z = f(r)$ ) by requiring the tangent component of the gravitational force to be balanced by the tangent component of the centrifugal force.

2) The curve in the attached figure is a progressive vector diagram constructed from current-meter observations at latitude 43 degrees, 9 minutes N in the Mediterranean Sea. Under the assumption of a uniform but time-dependent flow field in the vicinity of the mooring, the curve can be interpreted as the trajectory of a water parcel. Using the marks counting the days along the curve, show that this set of observations reveals the presence of inertial oscillations. What is the average orbital velocity in these oscillations?  
[CR94: Problem 2.7]



3) If streamfunction is defined using the sign convention  $\mathbf{u} = \mathbf{k} \times \nabla \psi$ , show that the geostrophic streamfunction is related to pressure by  $\psi = \frac{P}{f\rho}$ .

4) A blob of air is located at 70 degrees north latitude at an elevation of 3 kilometers. The blob moves due east at a uniform speed of 20m/s, and makes a complete circuit of the earth.

- In what direction does the Coriolis force act on the blob?
- Neglecting friction, in what direction does the horizontal pressure gradient force act on the blob?
- Is the pressure force weaker than, equal in magnitude to, or stronger than the Coriolis force? Explain briefly.