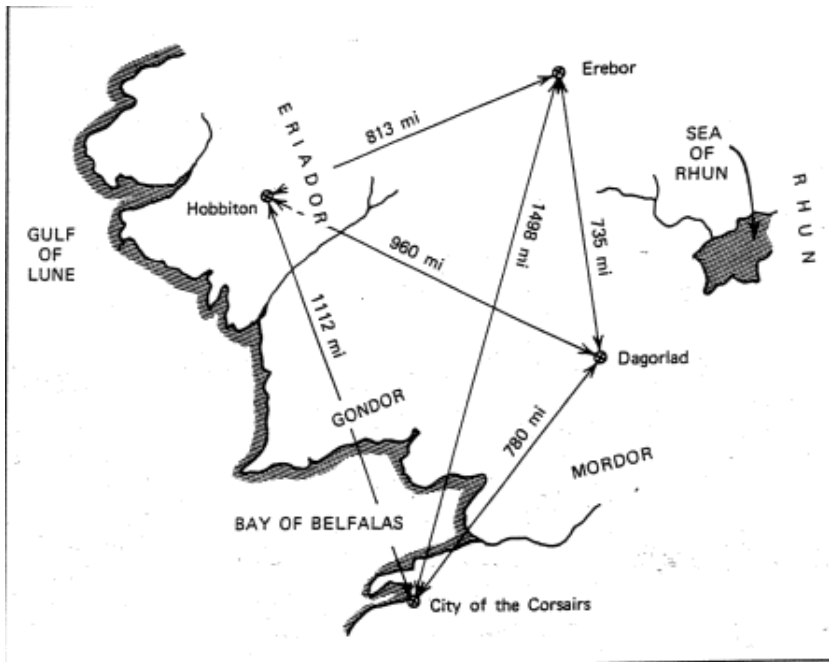


Physics 3368

Professor Olness

Astrophysics & Cosmology: Fall 2000



Map of Middle Earth. Is Middle Earth flat???

Assignment #2

Due: Thursday Sept 7

- 1) Is J.R.R. Tolkien's Middle earth flat?
Use the information contained in the handout figure.
- 2) Compute the Euler number ($F-E+V$) for the following objects.
 - a) a sphere
 - b) a doughnut
 - c) a two-holed doughnut
 - d) And, a 2nd sphere, but with a different dissection to show that the Euler number does not depend on the dissection.
- 3) The uncertainty principle allows us to violate ΔE if we do it

for a short Δt . Create an electron-positron pair at rest.
Estimate the lifetime (Δt) before we have to "pay-back" the uncertainty principle.

Repeat with a proton.

4) In flat space, the angles of a triangle sum to 2π . On the surface of a sphere, find (by guessing) a formula for the sum of the angles of a triangle.

Hint: your formula should involve the area of the triangle.

Test your formula for some simple examples.

5) The "Connection Machine" computer consisted of 64K of CPU's connected in a N-dimensional hypercube. Determine the dimension "N" of the hypercube needed to connect the machines. In this configuration, compute the MAXIMUM number of "links" it takes for one CPU to talk to another CPU.

6) For an N-dimensional (hyper)sphere, we discovered in $\{1,2,3\}$ dimensions that the interior is proportional to: $\{2r, \pi r^2, \frac{4}{3} \pi r^3\}$ and the boundary is proportional to: $\{2, 2 \pi r, 4 \pi r^2\}$. Find the corresponding answer for 4-dimensions. (Hint: your answer should probably involve the Gamma function.)

Extra credit: Find a general formula.