

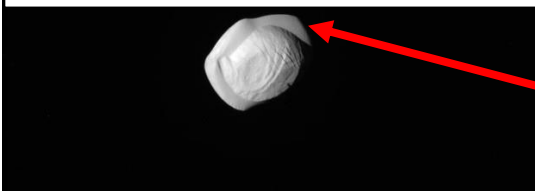
GRAVITY

Unit 8 Dr. John P. Cise, Professor of Physics, Austin Com. College, 1212 Rio Grande St. Austin

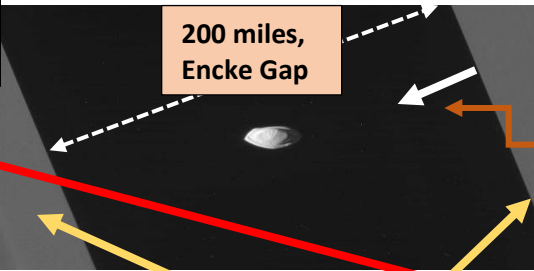
Tx., 78701, jpcise@austincc.edu & New York Times, March 10, 2017 by Kenneth Chang

Pan, Moon of Saturn, Looks Like a Cosmic Ravioli (or Maybe a Walnut)

The ridge is most likely a pile of ring dust that fell on the moon as it cleared out the Encke Gap



200 miles, Encke Gap



INTRODUCTION: Gravity provides force to accumulate dust from the ring along the way. Gravity ($G m_{\text{DUST}} M_{\text{PAN}} / R^2$) Pulls dust up to 100 miles away from Pan to Pan's surface. Up to 100 mi. away from Pan, gravity is strong enough to pull dust in.

A raw image of Pan, a moon of Saturn, captured by the Cassini spacecraft on Tuesday. The ridge around Pan's equator could be a couple of miles high and is likely made of dust from Saturn's rings.

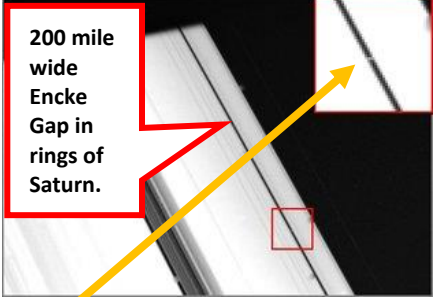
In a stunning set of close-ups, Pan, a diminutive moon of Saturn, looks like a floating ravioli lost in space, or a wrinkled flying saucer.

NASA's Cassini spacecraft took the photographs on Tuesday, passing within 15,268 miles of the moon, which has a ((diameter of about 20 miles)), roughly the size of New York City." These are the clearest images ever seen of Pan, named after the flute-playing Greek god of hunters and shepherds. They depict a ridge around the moon's Equator that rises perhaps a couple of miles.

Pan is one of Saturn's shepherd moons, clearing out a 200-mile-wide space in Saturn's rings known as the Encke Gap.

"To see it with that detail, to be able to count craters on it," said Mark R. Showalter, an astronomer at the SETI Institute in Mountain View, Calif., who discovered Pan in 1990, "I could remember when it was not even a pixel." In the mid-1980s, astronomers noticed that the ring edges along the gap had a scalloped appearance, almost like waves of water, possibly the wake of a small moon orbiting within the gap. By refining the calculations, Dr. Showalter, then at the NASA Ames Research Center, figured out an orbit for the unseen moon. He went back to images taken by the Voyager 2 spacecraft during its flyby of Saturn in 1981.

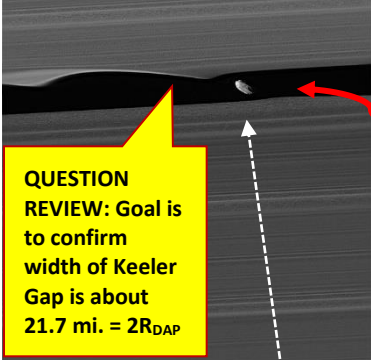
200 mile wide Encke Gap in rings of Saturn.



Introduction(continued): Gravity also provides force from Daphnis (see graphic in lower left) to accumulate dust from the Keeler ring. Along the way Gravity ($G m_{\text{DUST}} M_{\text{DAPHNIS}} / R^2$) Pulls dust up to R_D miles away from Daphnis to Daphnis's surface. Up to R_D mi. away from Daphnis gravity is strong enough to pull dust to Daphnis surface. Goal of this application is to find distance (R_D) the keeler Gap is from Daphnis moon. We will assume the dust in each gap (Encke & Keeler) has the same mass m . Thus, the minimum gravitational force to pull the dust to either moon is the same: $F_{\text{PAN}} = F_{\text{DAP}}$, ($G m_{\text{DUST}} M_{\text{PAN}} / R^2$) = ($G m_{\text{DUST}} M_{\text{DAPHNIS}} / R^2$) Thus, $M_{\text{PAN}} / R_{\text{PAN}}^2 = M_{\text{DAP}} / R_{\text{DAP}}^2$ (eq. 1), where $R_{\text{PAN}} = 100$ mi. stated in article above. $R_{\text{DAP}} = ?$ minimum distance dust can stay in ring away from Daphnis. The mass of each moon can be found with $M = \rho V$, where $\rho = \text{density}$, $V = \text{sphere vol.} = 4/3\pi r^3$

Mark R. Showalter, an astronomer, found a dot in an image taken by Voyager 2 — the discovery of Pan.

QUESTION REVIEW: Goal is to confirm width of Keeler Gap is about 21.7 mi. = $2R_{\text{DAP}}$



HINTS: From Wikipedia: $\rho_{\text{PAN}} = 0.42 \text{ g/cm}^3$, $\rho_{\text{DAP}} = 0.34 \text{ g/cm}^3$; from article $r_{\text{PAN}} = 10$ mi., $R_{\text{DAP}} = 2.5$ mi.,

QUESTIONS: (a) Find $R_{\text{DAP}} = ?$ distance closest dust (rest is pulled into Daphnis surface by gravity) to Daphnis moon. (b) Find (confirm) width of keeler gap to be ~ 21.7 mi. ?

ANSWERS: (a) $R_{\text{DAP}} = 11.2$ mi., (b) Keeler Gap = $2 R_{\text{DAP}} = 22.4$ mi., close to Wiki and NASA Statement of Keeler Gap width 21.7 mi. on average. Pure poetry....thanks to Newton's 4th. law.

Cassini took this image of Daphnis, a 5-mile-wide moon, in January. Daphnis' gravity also opened a gap in Saturn's rings and created the scalloped wave pattern at the ring edges.

PAN MOON

