



CINDI IN SPACE

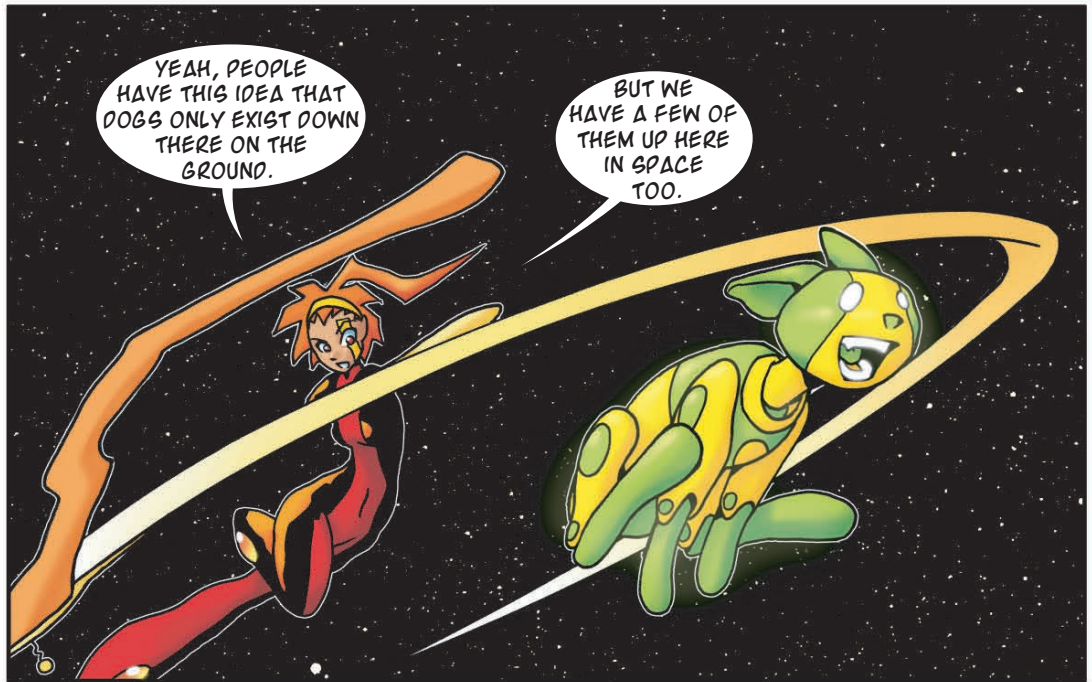


HI THERE!
MY NAME IS CINDI AND
I'M AN ANDROID GIRL! I LIVE
OUT HERE IN A SPACE STATION
IN ORBIT AROUND THE EARTH.
MY JOB IS TO CATCH
DOGS...

THAT'S
RIGHT.
DOGS...

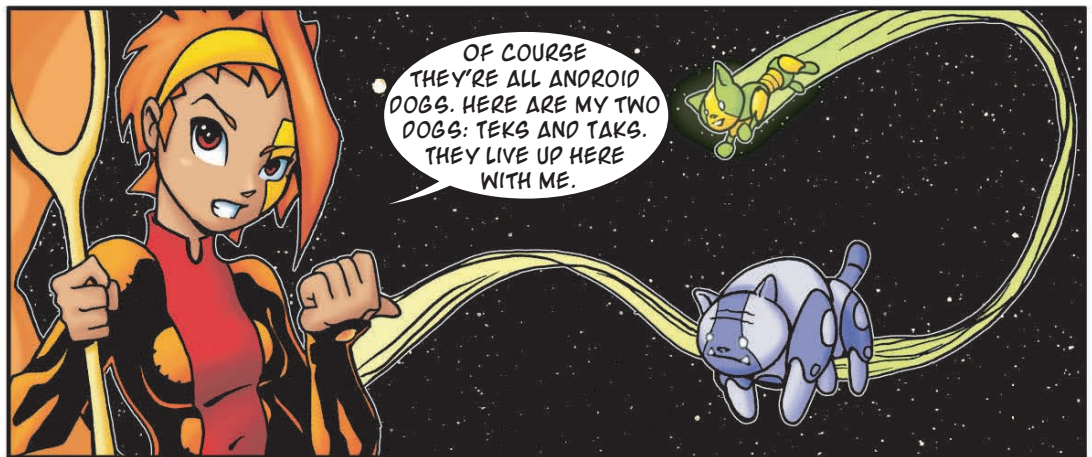
YOU MEAN
YOU'VE NEVER
HEARD OF
SPACE DOGS
BEFORE?



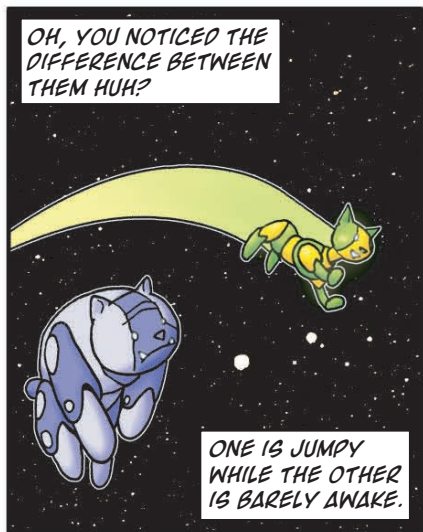


YEAH, PEOPLE HAVE THIS IDEA THAT DOGS ONLY EXIST DOWN THERE ON THE GROUND.

BUT WE HAVE A FEW OF THEM UP HERE IN SPACE TOO.

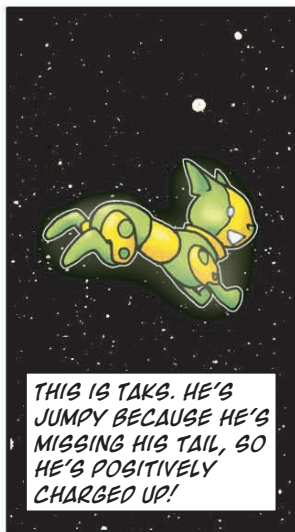


OF COURSE THEY'RE ALL ANDROID DOGS. HERE ARE MY TWO DOGS: TEKS AND TAKS. THEY LIVE UP HERE WITH ME.



OH, YOU NOTICED THE DIFFERENCE BETWEEN THEM HUH?

ONE IS JUMPY WHILE THE OTHER IS BARELY AWAKE.



THIS IS TAKS. HE'S JUMPY BECAUSE HE'S MISSING HIS TAIL, SO HE'S POSITIVELY CHARGED UP!



AND THIS IS TEKS. HE STILL HAS HIS TAIL SO HE'S NOT CHARGED UP AT ALL.

YOU SEE, THAT'S THE WAY ANDROID DOGS BEHAVE. THEY ARE ELECTRICAL AFTER ALL. THEIR BODIES HAVE POSITIVE CHARGE AND THEIR TAILS HAVE NEGATIVE CHARGE.



SO TEKS IS LIKE THIS SINCE HIS POSITIVE AND NEGATIVE CHARGED PARTS CANCEL OUT.



BUT HE'S LIKE THIS UNTIL HE EATS ONE OF THESE ENERGY BISCUITS.



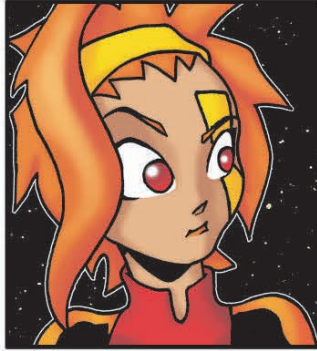
CHOMP
CHOMP



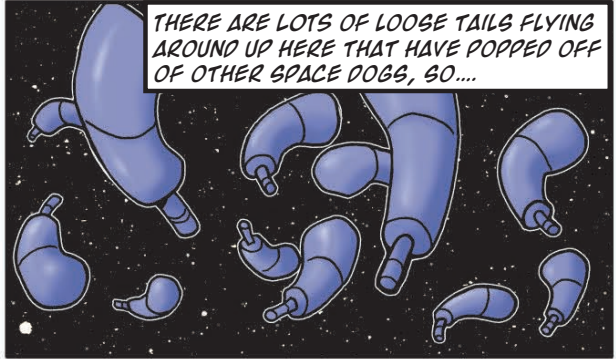
IF THERE IS ENOUGH ENERGY IN THE BISCUIT, HIS TAIL FLIES OFF AND HE BECOMES ENERGIZED.



FORTUNATELY, THEY DON'T STAY LIKE THIS ALL THE TIME.



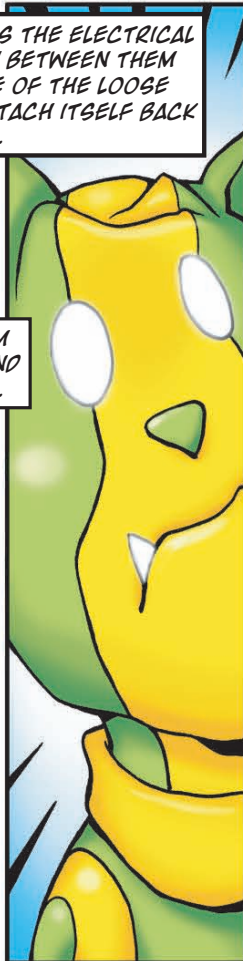
THERE ARE LOTS OF LOOSE TAILS FLYING AROUND UP HERE THAT HAVE POPPED OFF OF OTHER SPACE DOGS, SO....



...SOMETIMES THE ELECTRICAL ATTRACTION BETWEEN THEM CAUSES ONE OF THE LOOSE TAILS TO ATTACH ITSELF BACK ON THE DOG.



THAT MAKES THEM NEUTRAL AGAIN AND THEY CALM DOWN.

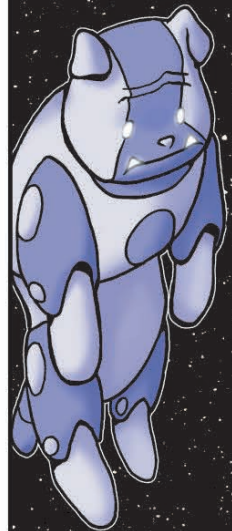


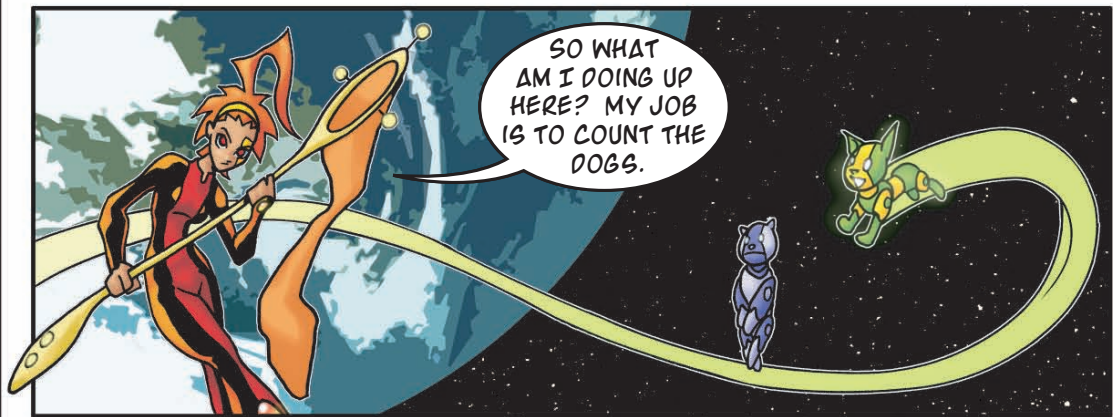
OH YEAH, WHEN THE TAIL REATTACHES THEY HAVE TO GET RID OF THE EXTRA ENERGY...



...SO SOMETIMES THEY SPIT OUT ANOTHER ENERGY BISCUIT.

IF THIS WAS A REAL DOG, THIS WOULD BE **GROSS!** FORTUNATELY THEY'RE ANDROIDS, SO IT'S NOT.





SO WHAT AM I DOING UP HERE? MY JOB IS TO COUNT THE DOGS.



THAT'S RIGHT. COUNT DOGS.



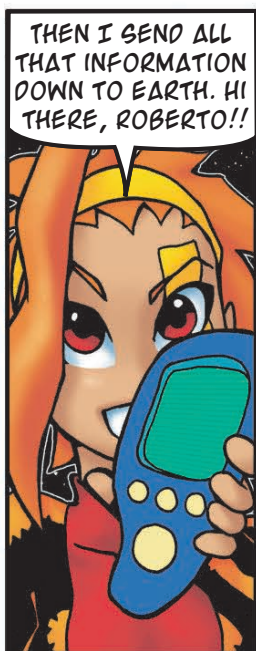
THE SCIENTISTS DOWN ON EARTH WANT TO KEEP TRACK OF HOW MANY DOGS THERE ARE UP HERE.



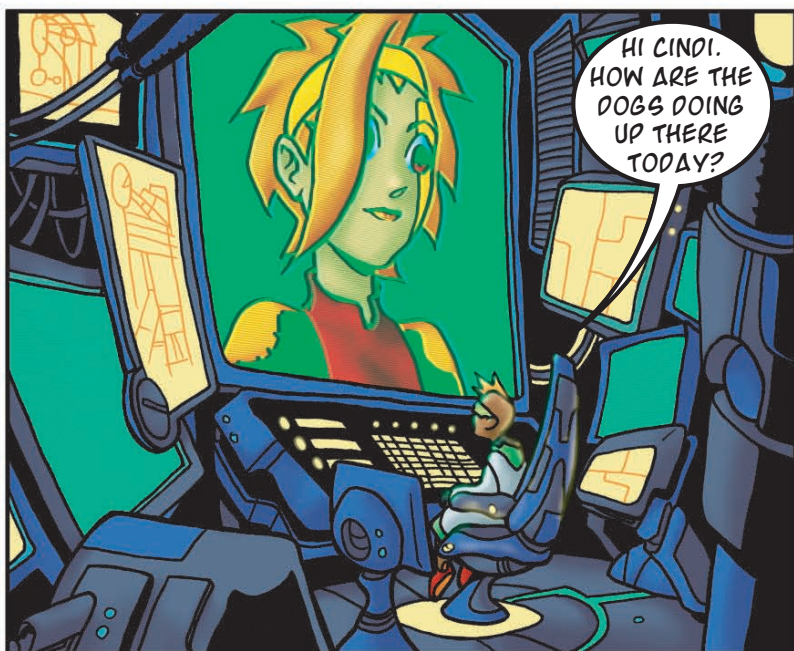
SO I CATCH THE DOGS WITH MY NET...



...COUNT THEM ALL, AND FIGURE OUT WHETHER THEY'RE ENERGIZED OR NOT.



THEN I SEND ALL THAT INFORMATION DOWN TO EARTH. HI THERE, ROBERTO!!



HI CINDI. HOW ARE THE DOGS DOING UP THERE TODAY?




OH, THE USUAL. THEY'RE JUMPING ALL OVER THE PLACE.




WELL, IT LOOKS LIKE YOU'LL GET SOME MORE EXCITEMENT.

THE FORECASTERS ARE PREDICTING A BIG PACK OF DOGS JUST AFTER YOU GO THROUGH SUNSET.



ROGER THAT! WE SHOULD BE ORBITING AROUND TO THE NIGHTSIDE IN JUST A FEW MINUTES. GOTTA GET READY! BYE, ROBERTO!



YOU'RE PROBABLY WONDERING WHY I HAVE TO HAVE TWO NETS HERE.

I HAVE TO USE ONE KIND FOR THE JUMPY DOGS AND A DIFFERENT KIND FOR THE SLEEPY DOGS. WATCH THIS!





SO YOU'VE GOT TO USE THE RIGHT NET FOR THE RIGHT DOG!



THANKS FOR THE HELP, GUYS.

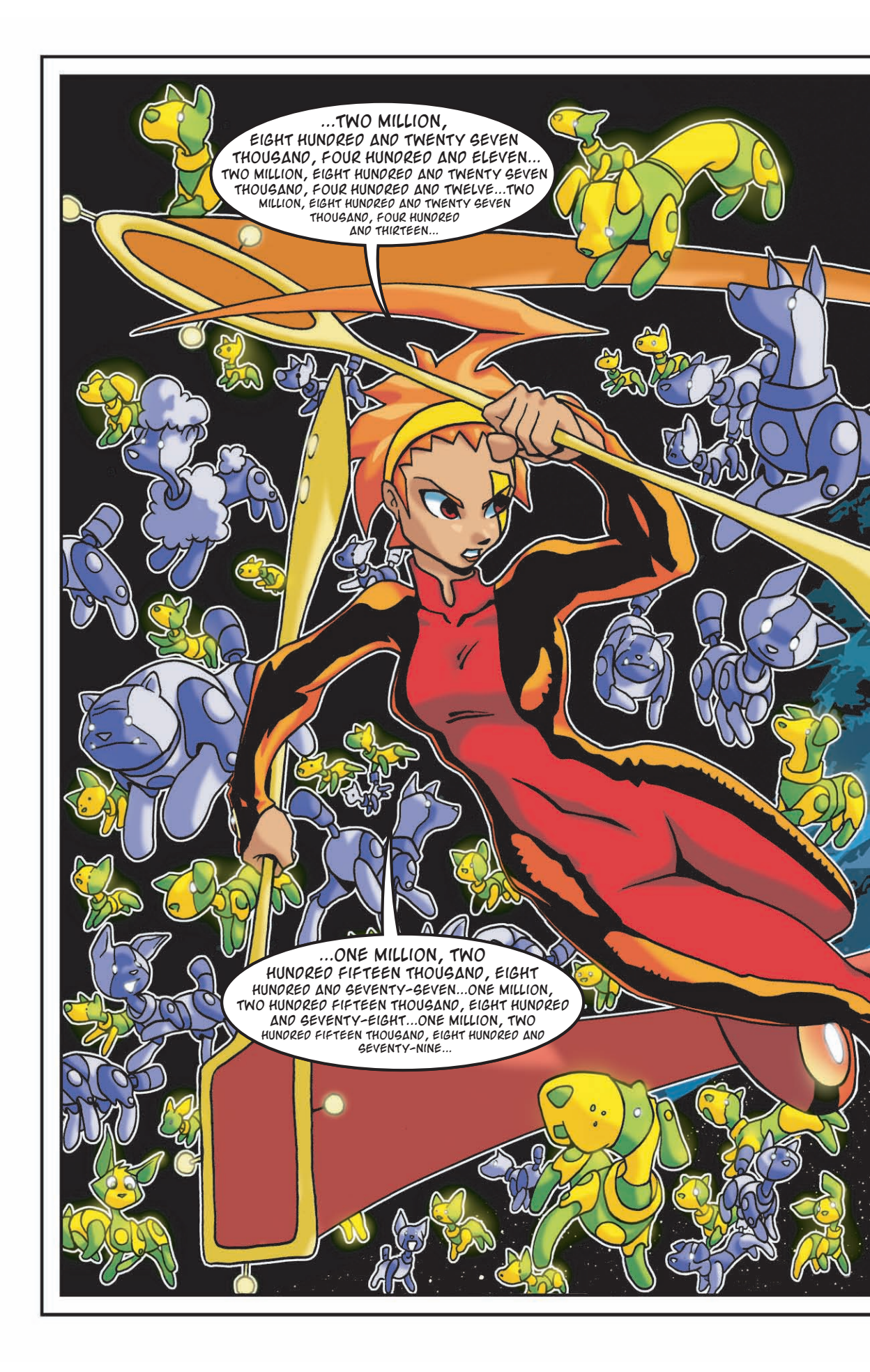


NOW WE'RE COMING AROUND TO THE NIGHT SIDE OF THE EARTH, JUST AFTER SUNSET,



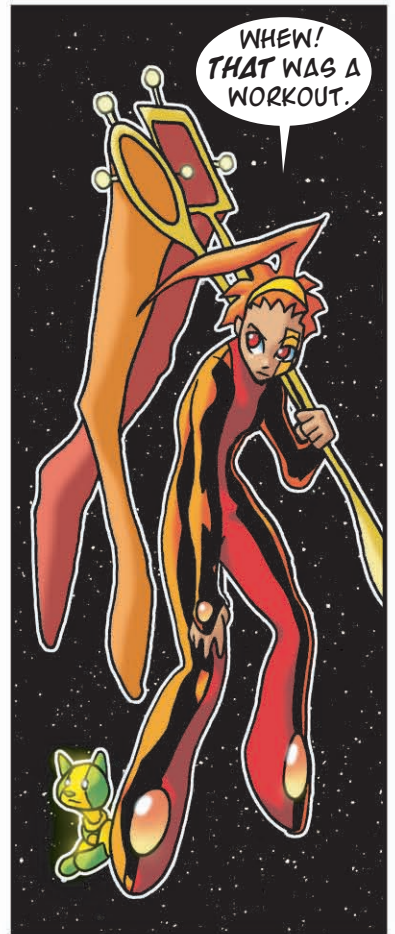
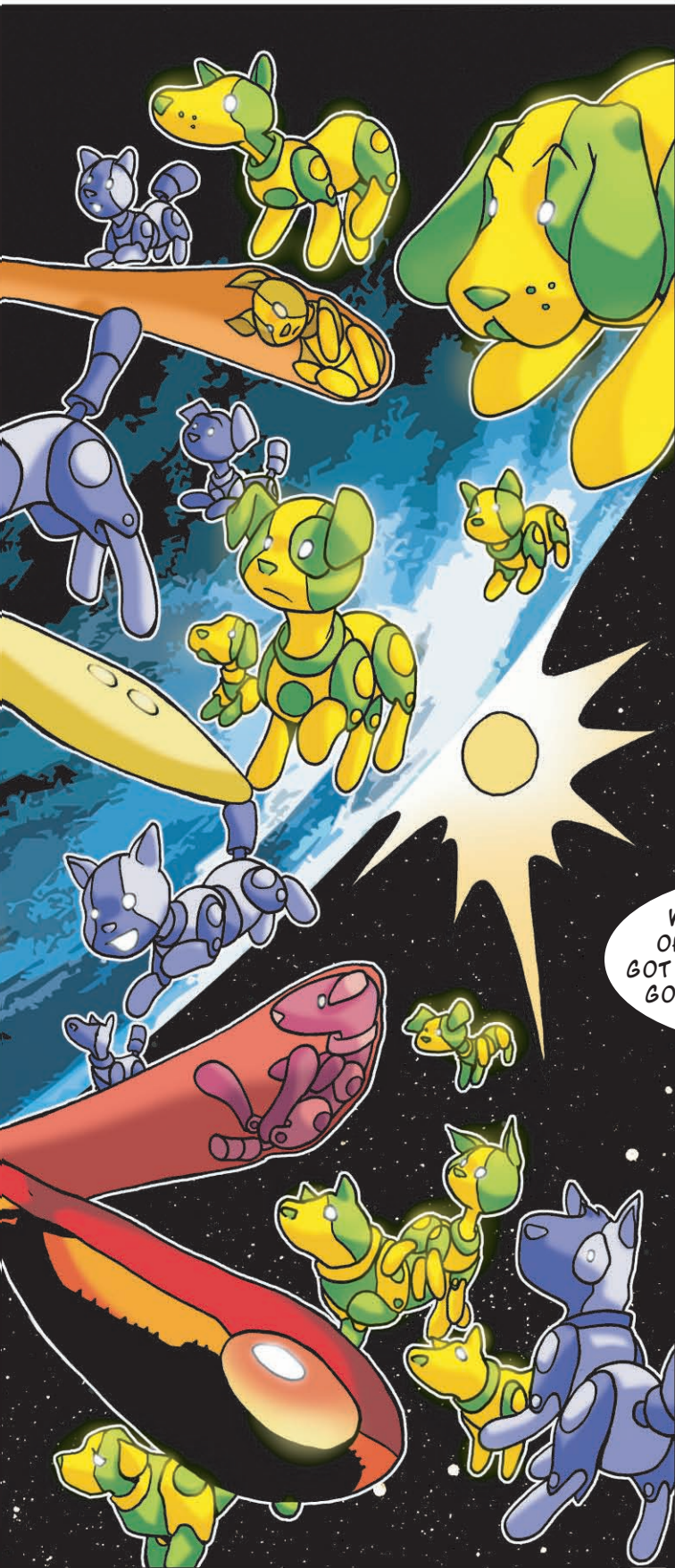
AND THAT'S WHERE WE FIND THE INTERESTING GROUPS OF SPACE DOGS.

THERE'S THE PACK! LET'S GO!

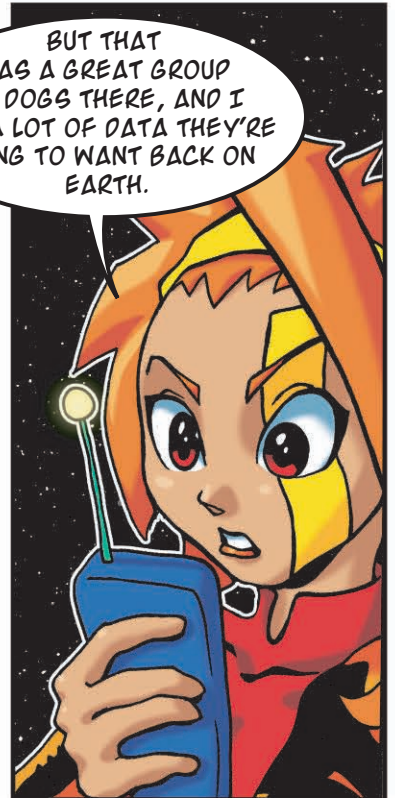


...TWO MILLION,
EIGHT HUNDRED AND TWENTY SEVEN
THOUSAND, FOUR HUNDRED AND ELEVEN...
TWO MILLION, EIGHT HUNDRED AND TWENTY SEVEN
THOUSAND, FOUR HUNDRED AND TWELVE...TWO
MILLION, EIGHT HUNDRED AND TWENTY SEVEN
THOUSAND, FOUR HUNDRED
AND THIRTEEN...

...ONE MILLION, TWO
HUNDRED FIFTEEN THOUSAND, EIGHT
HUNDRED AND SEVENTY-SEVEN...ONE MILLION,
TWO HUNDRED FIFTEEN THOUSAND, EIGHT HUNDRED
AND SEVENTY-EIGHT...ONE MILLION, TWO
HUNDRED FIFTEEN THOUSAND, EIGHT HUNDRED AND
SEVENTY-NINE...



BUT THAT WAS A GREAT GROUP OF DOGS THERE, AND I GOT A LOT OF DATA THEY'RE GOING TO WANT BACK ON EARTH.





HOLA ROBERTO! I FINISHED WITH THAT PACK OF DOGS. I'M SENDING THE DATA NOW!

THANKS CINDI! WE GOT IT ALL NOW.

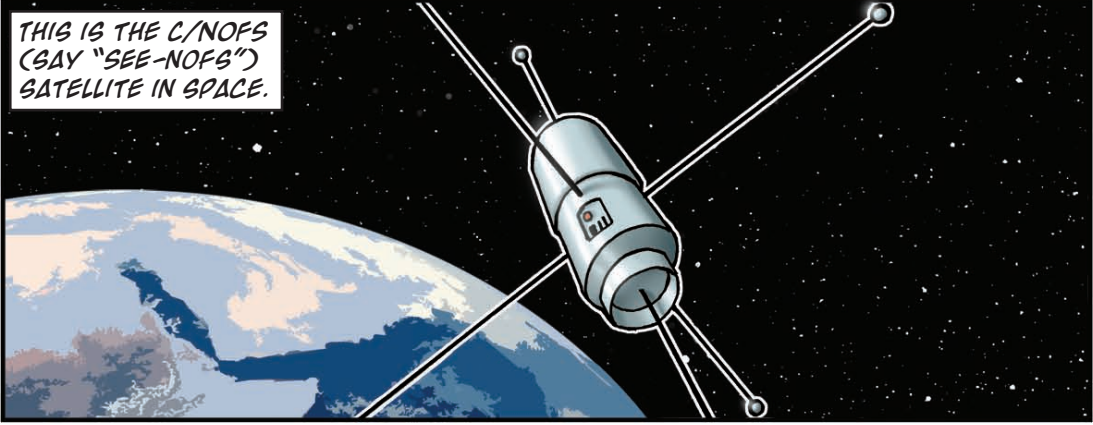


OKAY, ROBERTO! TALK TO YOU LATER!

WELL NOW THAT I'VE SHOWN YOU WHAT MY LIFE IS LIKE, LET ME SHOW YOU WHAT THE REAL CINDI IS LIKE AND WHAT IT DOES.



THIS IS THE C/NOFS
(SAY "SEE-NOFS")
SATELLITE IN SPACE.



THE US AIR FORCE PUT IT INTO ORBIT
AROUND THE EQUATOR AT ABOUT 550
KILOMETERS (OR 350 MILES) UP.



NOTE: PICTURE NOT TO SCALE. C/NOFS SHOULD BE
MUCH CLOSER TO THE EARTH.

MOST
FOLKS THINK
THAT SPACE UP
HERE IS EMPTY--
A COMPLETE
VACUUM.



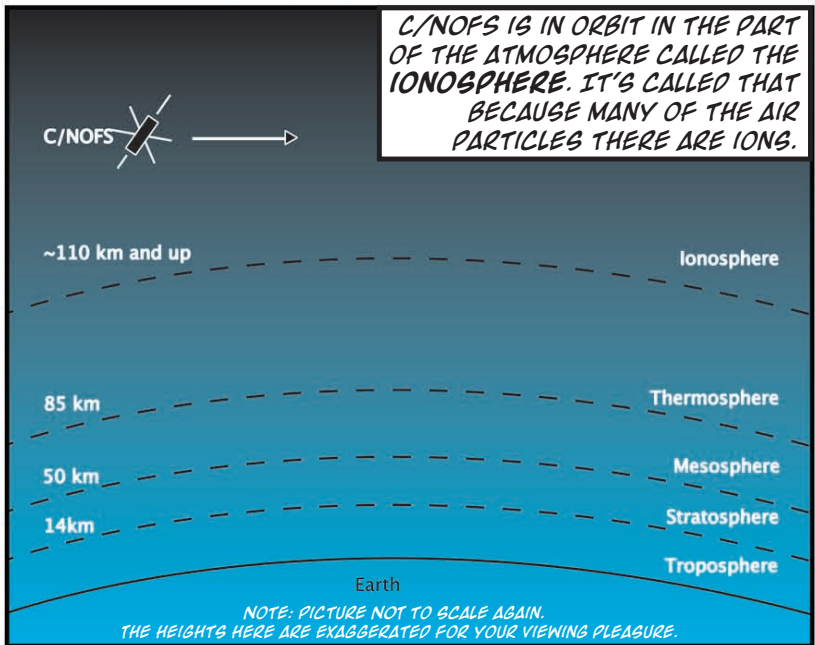
BUT INSIDE THIS
ONE CENTIMETER
CUBE UP HERE
THERE ARE STILL
ABOUT 10 MILLION
ATOMS AND
MOLECULES OF AIR!



NOW THAT MAY SEEM
LIKE A LOT, BUT DOWN
ON EARTH WHERE YOU
ARE, THAT SAME CUBE
WOULD HAVE ABOUT
10 MILLION MILLION
MILLION ATOMS AND
MOLECULES!



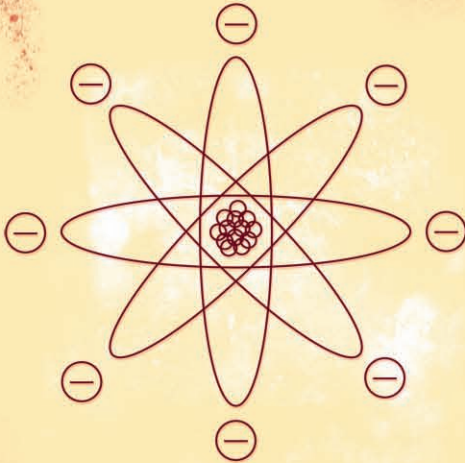
C/NOFS IS IN ORBIT IN THE PART
OF THE ATMOSPHERE CALLED THE
IONOSPHERE. IT'S CALLED THAT
BECAUSE MANY OF THE AIR
PARTICLES THERE ARE IONS.



NOTE: PICTURE NOT TO SCALE AGAIN.
THE HEIGHTS HERE ARE EXAGGERATED FOR YOUR VIEWING PLEASURE.

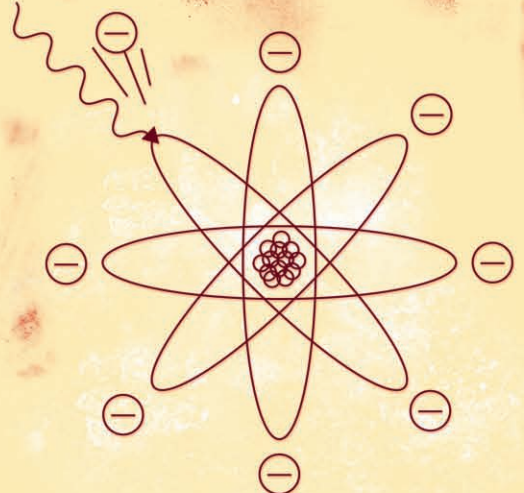
HERE'S A TYPICAL OXYGEN ATOM YOU WOULD FIND IN THE UPPER ATMOSPHERE. IT HAS AN EQUAL NUMBER OF POSITIVE PROTONS IN ITS CENTER AS IT HAS NEGATIVE ELECTRONS GOING AROUND IT. SO IT'S NEUTRAL, IT HAS NO NET CHARGE.

THE "OXYGEN" YOU BREATHE DOWN THERE IS REALLY A MOLECULE OF TWO OXYGEN ATOMS. WE'RE JUST SHOWING ONE OXYGEN ATOM HERE BECAUSE THAT'S THE WAY IT IS IN THE IONOSPHERE ...AND BECAUSE IT'S A LOT EASIER TO DRAW JUST ONE.



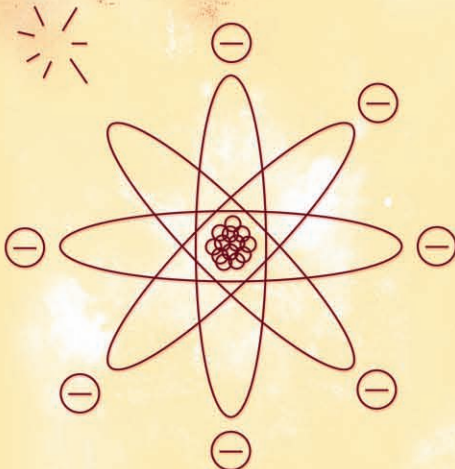
8 protons (+) + 8 electrons (-)
Net Charge = 0

BUT SOMETIMES WHEN THE ATOM ABSORBS A PHOTON OF LIGHT, THE EXTRA ENERGY CAUSES ONE OF ITS ELECTRONS TO GET KICKED OFF. JUST LIKE ONE OF THE SPACEDOGS LOSING A TAIL WHEN THEY EAT AN ENERGY BISCUIT.

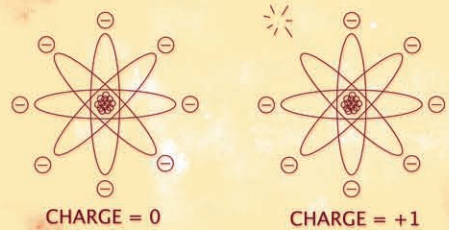


Net Charge = ?

NOW THE ATOM HAS ONE MORE POSITIVE CHARGE THAN NEGATIVE CHARGE, SO ITS NET ELECTRICAL CHARGE IS +1.



8 protons (+) + 7 electrons (-)
Net Charge = +1



NEUTRAL

ION

WE CALL AN ATOM OR MOLECULE WITH NO NET CHARGE A "NEUTRAL"...

AND AN ATOM OR MOLECULE WITH A CHARGE AN "ION."





UP HERE IN SPACE THE IONS AND NEUTRALS ACT DIFFERENTLY.

A NEUTRAL JUST MOVES UNDER THE COMBINED FORCES OF GRAVITY AND PRESSURE.

NEUTRAL

BUT SINCE AN ION IS ELECTRICALLY CHARGED, IT ALSO FEELS THE FORCE OF THE ELECTRIC FIELDS AND MAGNETIC FIELDS UP HERE. SO IT MOVES AROUND UNDER THE COMBINED EFFECT OF ALL FOUR FORCES, AND GENERALLY TRIES TO MOVE IN A DIFFERENT DIRECTION THAN THE NEUTRALS ARE MOVING.

ION

IF WE HAD JUST NEUTRALS OR JUST IONS... ...THEY WOULD ALL MOVE TOGETHER IN THE SAME DIRECTION.

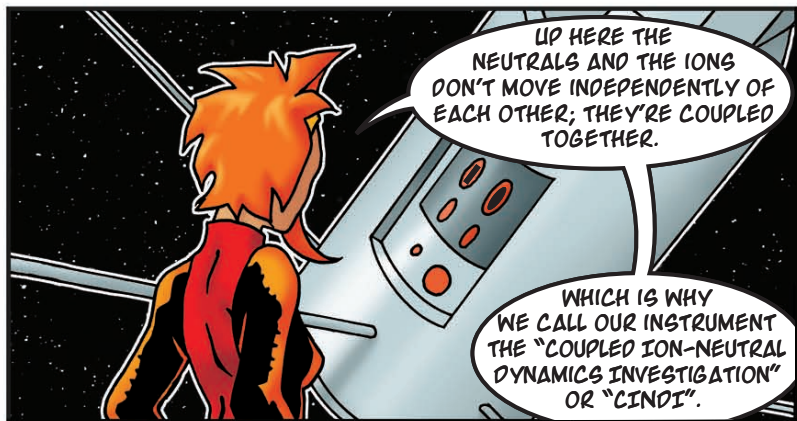
NEUTRAL

ION

NEUTRAL

ION

BUT SINCE THEY MOVE IN DIFFERENT DIRECTIONS, THEY BUMP INTO EACH OTHER ALL THE TIME, AND THAT MAKES THEM MOVE IN EVEN MORE COMPLICATED DIRECTIONS!

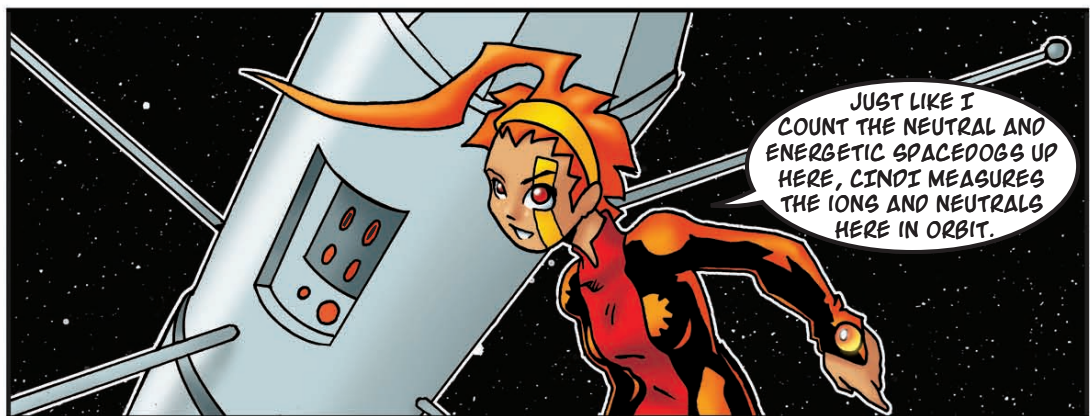


UP HERE THE NEUTRALS AND THE IONS DON'T MOVE INDEPENDENTLY OF EACH OTHER; THEY'RE COUPLED TOGETHER.

WHICH IS WHY WE CALL OUR INSTRUMENT THE "COUPLED ION-NEUTRAL DYNAMICS INVESTIGATION" OR "CINDI".



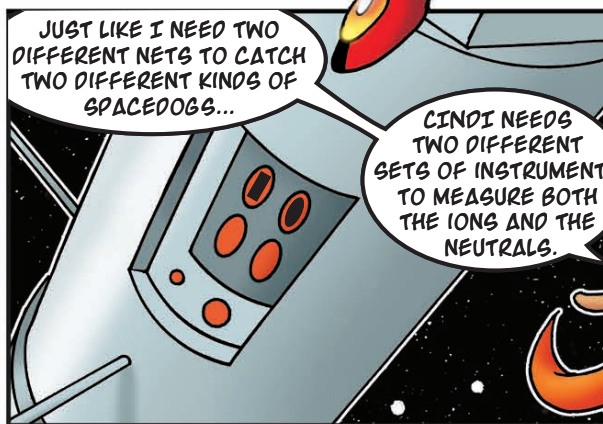
...AND I USED TO THINK THEY NAMED IT AFTER ME...



JUST LIKE I COUNT THE NEUTRAL AND ENERGETIC SPACEDOGS UP HERE, CINDI MEASURES THE IONS AND NEUTRALS HERE IN ORBIT.



AFTER IT MAKES THE MEASUREMENTS, THAT INFORMATION IS RADIOED BACK TO THE SCIENTISTS ON THE GROUND.

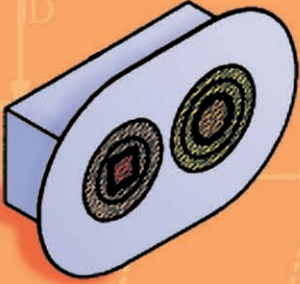


JUST LIKE I NEED TWO DIFFERENT NETS TO CATCH TWO DIFFERENT KINDS OF SPACEDOGS...

CINDI NEEDS TWO DIFFERENT SETS OF INSTRUMENTS TO MEASURE BOTH THE IONS AND THE NEUTRALS.

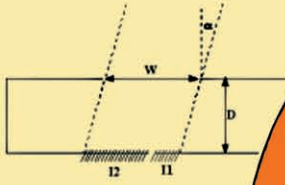


THIS IS THE ION VELOCITY METER OR IVM. IT HAS TWO PARTS AND IT DETECTS ONLY THE IONS THAT GET INSIDE AND IGNORES THE NEUTRALS.



ARRIVAL ANGLE MEASUREMENT

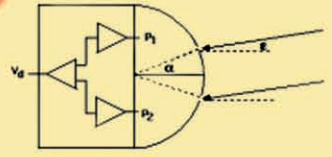
Ion Drift Meter



$$\frac{I_1}{I_2} = \frac{W/2 - D \tan \alpha}{W/2 + D \tan \alpha}$$

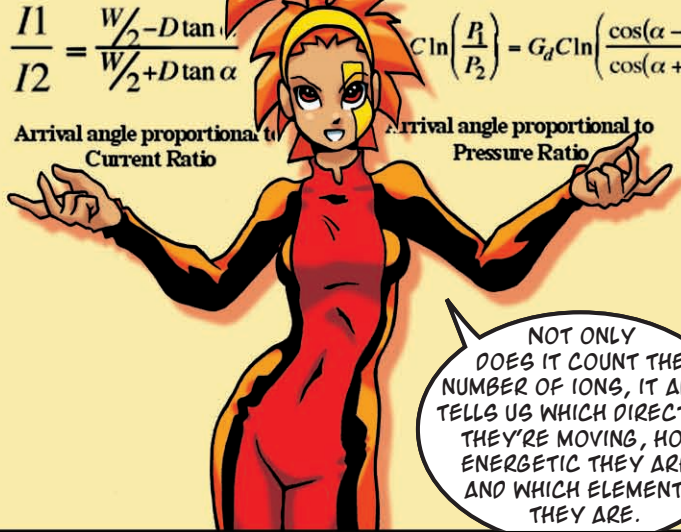
Arrival angle proportional to Current Ratio

Cross-Track Wind Sensor



$$C \ln \left(\frac{P_1}{P_2} \right) = G_d C \ln \left(\frac{\cos(\alpha - \epsilon)}{\cos(\alpha + \epsilon)} \right)$$

Arrival angle proportional to Pressure Ratio

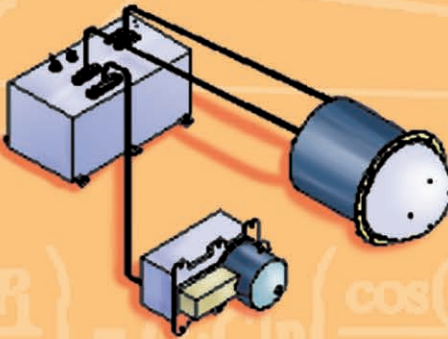


NOT ONLY DOES IT COUNT THE NUMBER OF IONS, IT ALSO TELLS US WHICH DIRECTION THEY'RE MOVING, HOW ENERGETIC THEY ARE, AND WHICH ELEMENTS THEY ARE.

THIS IS THE NEUTRAL WIND METER OR NWM.



IT ALSO HAS TWO PARTS, AND IT HAS AN ELECTRIC FIELD IN FRONT OF IT TO KEEP THE IONS OUT SO IT ONLY MEASURES THE NEUTRALS.



JUST LIKE THE IVM, THE NWM COUNTS THE NUMBER OF NEUTRALS AND TELLS US IN WHAT DIRECTION THEY'RE MOVING.

SO WHY WOULD ANYONE CARE ABOUT MEASURING THESE IONS AND NEUTRALS OUT IN SPACE?

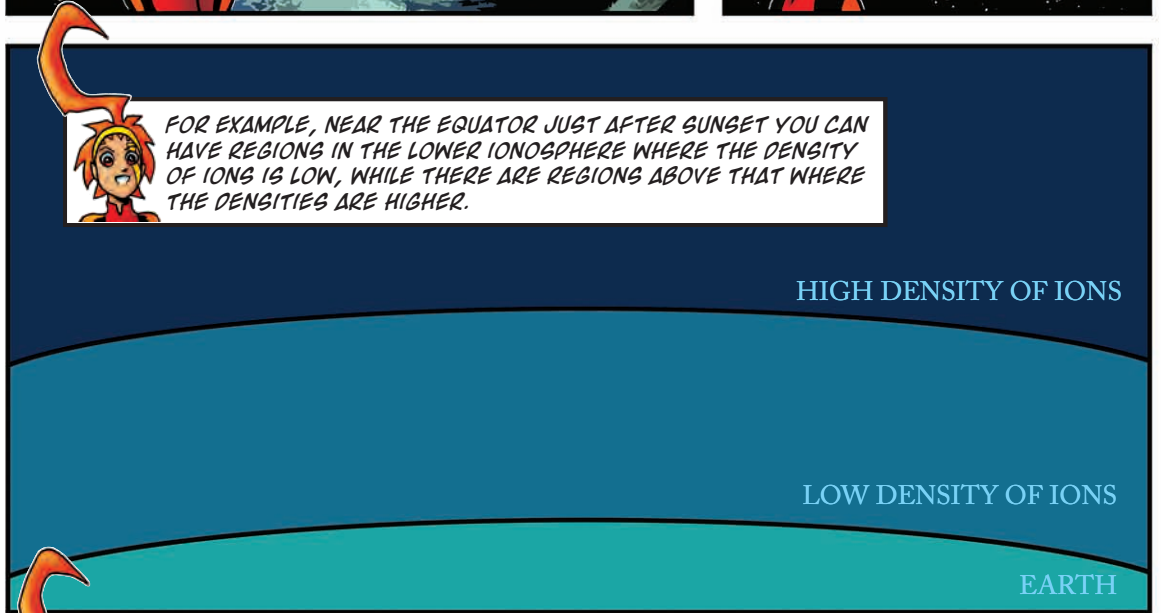




WELL, THESE DIFFERENT FORCES AFFECTING THE IONS AND NEUTRALS UP HERE CREATE BIG STRUCTURES IN THE IONOSPHERE THAT ARE ALWAYS CHANGING.



IT'S JUST LIKE THE WEATHER THAT'S ALWAYS CHANGING DOWN THERE WHERE YOU ARE. IN FACT, THAT'S WHY WE ALL THIS "SPACE WEATHER".



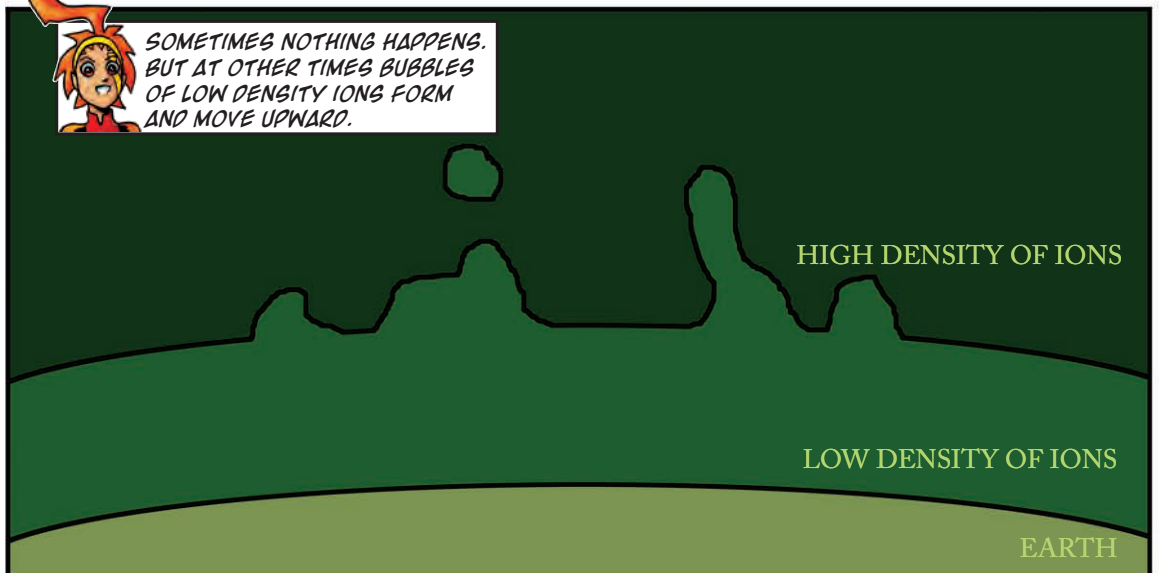
HIGH DENSITY OF IONS

LOW DENSITY OF IONS

EARTH



FOR EXAMPLE, NEAR THE EQUATOR JUST AFTER SUNSET YOU CAN HAVE REGIONS IN THE LOWER IONOSPHERE WHERE THE DENSITY OF IONS IS LOW, WHILE THERE ARE REGIONS ABOVE THAT WHERE THE DENSITIES ARE HIGHER.



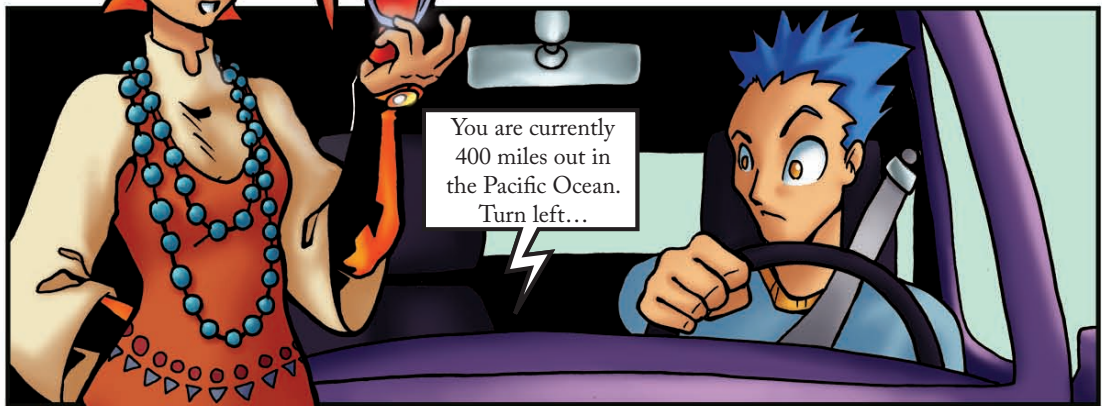
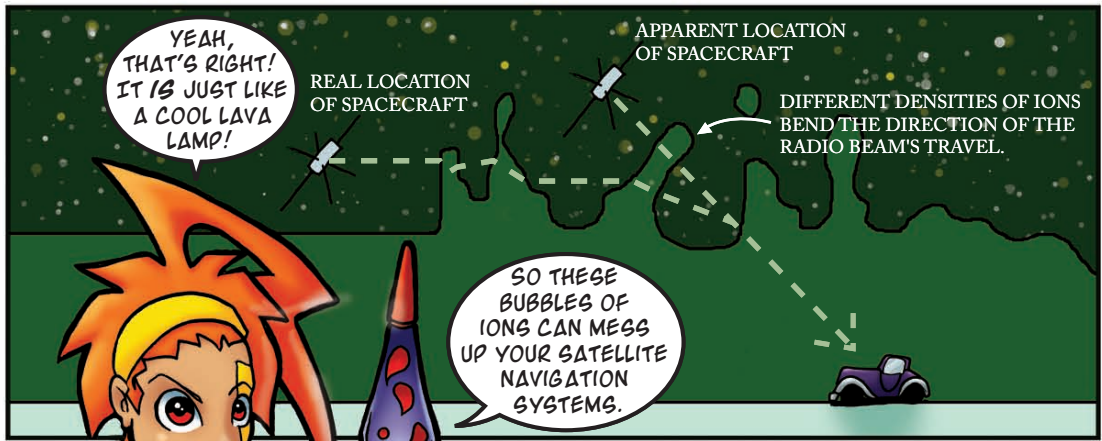
HIGH DENSITY OF IONS

LOW DENSITY OF IONS

EARTH



SOMETIMES NOTHING HAPPENS. BUT AT OTHER TIMES BUBBLES OF LOW DENSITY IONS FORM AND MOVE UPWARD.



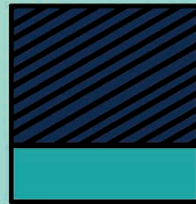
BUT THIS DOESN'T HAPPEN ALL OF THE TIME, JUST SOME OF THE TIME. LIKE I SAID, IT'S JUST LIKE WEATHER.



DAY BEFORE YESTERDAY



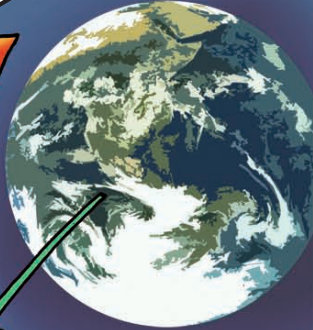
YESTERDAY



TODAY

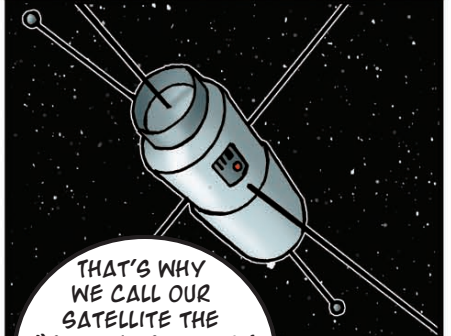
IF WE COULD FORECAST THE SPACE WEATHER JUST LIKE WE FORECAST THE WEATHER DOWN ON THE GROUND, THEN WE'D KNOW AHEAD OF TIME WHEN THESE BUBBLES WERE GOING TO INTERFERE WITH OUR SATELLITES.

Strong Solar Winds
Tomorrow



Southern Aurora
Tonight
80% Chance
Of Bubbles

Heightened
Kp Index



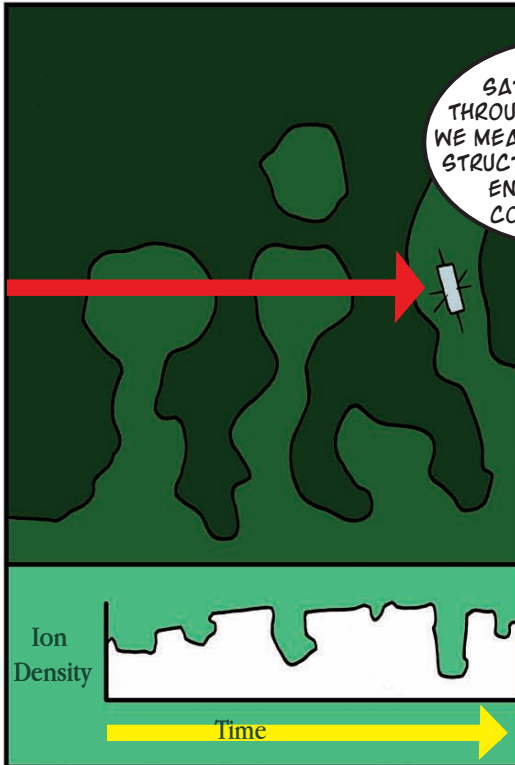
THAT'S WHY WE CALL OUR SATELLITE THE "COMMUNICATIONS/ NAVIGATION OUTAGE FORECAST SATELLITE" OR "C/NOFS".



NO, I DON'T THINK THAT NAME IS ANYWHERE NEAR AS NICE AS CINDI EITHER...



AS THE SATELLITE FLIES THROUGH THE BUBBLES WE MEASURE THEIR SIZE, STRUCTURE, DENSITIES, ENERGIES, AND COMPOSITION.



YOU SEE,
BY MEASURING
THESE CONDITIONS IN THE
IONOSPHERE BOTH BEFORE
THE BUBBLES OCCUR AND THEN
AFTER THEY FORM, WE
CAN FIGURE OUT HOW TO
PREDICT WHEN AND
WHERE THEY WILL
HAPPEN.



IT'S JUST
LIKE WEATHER
WARNINGS ON THE
GROUND. IF WE CAN
FORECAST WHEN AND
WHERE THESE BUBBLES
WILL HAPPEN, THEN WE
CAN TAKE ACTIONS TO
WORK AROUND THE
PROBLEMS THEY
CAUSE FOR OUR
SATELLITES
AND...



HEY,
CINDI!!





WE JUST GOT ANOTHER REPORT OF A PACK OF SPACE DOGS NEAR YOU. CAN YOU GO CHECK IT OUT?



WELL, I'VE
GOT TO GO CHECK
OUT THOSE SPACE
DOGS. COME BACK
SOON FOR MORE
ADVENTURES!

AND
KEEP LEARNING!
BYE!





WOULD YOU LIKE TO KNOW MORE ABOUT THE CINDI INSTRUMENT, THE C/NOFS SATELLITE, THE IONOSPHERE, AND EVEN DOWNLOAD A COPY OF MY ADVENTURES HERE TO PRINT OUT ON YOUR OWN? THEN COME TO OUR REALLY COOL WEBSITE:

[HTTP://CINDISPACE.UTDALLAS.EDU/EDUCATION/](http://cindispace.utdallas.edu/education/)

WE HAVE MORE INFORMATION ABOUT THE CINDI MISSION THERE, CLASSROOM PROJECTS, CURRICULUM STUFF FOR TEACHERS, AND EVEN REAL DATA FROM CINDI, AND PROJECTS YOU CAN DO TO ANALYZE THE DATA! COME SEE THE LATEST CINDI NEWS THERE!

AND HERE ARE ALL THE FOLKS WHO CREATED ALL THIS:
STORY BY: **DR. MARY URQUHART AND DR. MARC HAIRSTON**

SCRIPT AND STORYBOARDING BY: **DR. MARC HAIRSTON**
AMAZING CHARACTER DESIGNS, STUPENDOUS ARTWORK, STUNNING LAYOUTS, AND IMPECCABLE LETTERING BY: **ERIK LEVOLD**

COLORING BY: **DIANA MARSH AND JESSICA FUCHS**
ORIGINAL CONCEPT OF CINDI CHARACTER CREATED BY: **DR. MARY URQUHART, DR. MARC HAIRSTON, JIM RICHARDSON, AND CHARLENE OLSEN.**
CINDI COMIC PROJECT DIRECTOR: **DR. MARC HAIRSTON**

SPECIAL THANKS TO **DR. FRENCHY LUNNING** AT THE MINNEAPOLIS COLLEGE OF ART AND DESIGN

NO PROTONS OR ELECTRONS WERE HARMED IN THE MAKING OF THIS BOOK.

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