Cryogenics Symposium

Day 1 – Thursday March 31, 2011

1. Evaporative Cooling- Sahar Mirshamsi
2. Peltier Effect Bobby Bond
3. Dewar's Flask and Cryogenic Storage Roberto Gomez-Perez
4. Cooling Computers Brady Nash
5. Vortex Tube Cooling Joseph Smales
6. Pulse Tube Refrigeration- Scott Petersen
7. Food Processing and Storage Gabriel Dilanji

Evaporate Cooling

Sahar Mirshamsi

• **Science of Evaporate cooling, basic ideas**: Evaporative cooling is based on a physical phenomenon in which evaporation of a liquid (usually water) into surrounding air cools an object or a liquid in contact with it.

• **Evaporative Coolers:** Also known as swamp coolers, sump coolers or desert coolers are most commonly found in homes and small businesses located in dry hot climates.

•**"Badgir", a traditional windcatcher in Iran:** The dry and warm wind will pass over a pond with a fountain gets cool and wet through evaporation**.**

•**Cooling Towers**

(If it does not make the talk longer than 8 minutes)

Peltier Effect

•Materials used to make Thermoelectric coolers

•Figure of Merit

•Improving Figure of Merit

•Disadvantages

•Advantage

•Applications of Thermoelectric Cooling

•Common Devices

Sources (not all):

•http://www.electronics-cooling.com/2006/11/effect-of-improved-thermoelectric-zts-on-electronic-module-coolability/

•http://www.tec-microsystems.com/EN/Intro_Thermoelectric_Coolers.html

Dewar's Flask and Cryogenics Storage Outline

INTRODUCTION
- Sir. James Dewar
- Modern applications
  - Gravity Probe b
  - Thermos

Dewar's Flask
- Original
  - Materials
  - Pictures
- Development
  - Seal
  - Fill
  - Out gassing
  - Getters
- Use
- Modern designs
  - Pictures

Other Storage Devices
- Different types
  - Liquid cylinders
  - Tanks
  - When these devices where created
  - Differences in use compared to Dewar's flask

Conclusion

Computer Cooling

Brady Nash

- Heat Buildup and Hardware Damage
- Types of System Cooling & Implementation
  - Air Cooling
  - Liquid Submersion
- Types of Spot Cooling & Implementation
  - Passive/Active heat-sinks
  - Water cooling
  - Heat Pipes
  - Phase-change cooling
  - Liquid nitrogen cooling
- Overclocking & Cooling Cautions

Vortex Tube Cooling Outline

Joseph Smales

- Brief History
  - Invented: 1933 Georges J. Ranque
  - Design improved & Large publication: 1947 Rudolf Hilsch
- Theory as to how it works:
  - Compressed air→vortex motion→hot out /reverse flow→cool out, opposite hot
  - Pressure differences and conservation of angular momentum
  - C.L. Stong
  - J. J. Van Deemter,
- Basic design considerations
- Efficiency
  - Data tables from various manufacturers
- Applications
  - Poor efficiency: good for "spot" cooling
  - Cooling electrical cabinets
- Possible demo
- Clicker Question

pulse tube refrigeration

Slide 1: Introduction
Basic overview of pulse tube refrigeration
How it uses acoustics and involves no cold moving parts
Slide 2: Beginning Research
NASA origins for space applications: lower mass and longer life
Originally abandoned due to discouraging results
Phase shift discovery opened topic back up
Slide 3: Picture Description
Using a picture of a pulse tube refrigerator, I'll go over the components of the diagram
How it is a Stirling-type
Slide 4: Individual Components
Compressed gas traveling through system
Explain regenerator and heat exchangers
Slide 5: Comparison to other refrigerators
No need for displacer
Efficient (very little interferences)
Can only reach temperatures around 1 K
Slide 6: Current Uses
Very popular in space applications (telescopes)
Ben and Jerry's interest in thermoacoustics
Semiconductor fabrication
Slide 7: Future possibilities
Most effective at very low temperatures (not good for room temperature applications)
Combining dilution refrigerators and pulse tubes can achieve milli and micro K temperatures without prohibitive cost
Infrared detection, telecommunication filters

Food Processing and Storage Gabriel Dilanji

- To be continued

Cryogenics Symposium

Day 2– Tuesday April 5, 2011

1.	Superfluidity	Kristin Zych
2.	SuperSolid	Icon Mazzaccar
3.	Vortex State-type II superconductors	Joshua Arlund
4.	Superconducting Magnets	Lana Muniz
5.	Nuclear Demagnetization Cooling	Roman Ciapurin
6.	CDF Cryo System	Matt Snowball
7.	Quantum Computing	Adam Butler

Superfluidity Outline

Discovery
-when, by whom
Properties
-lambda point, viscosity
Theory
-Bose/Fermi statistics
Applications
-superconductors
Recent developments
-supersolids

Supersolids

- What is a supersolid and what are its characteristics?
- Motivation for the existence of a supersolid.
  - "Speculations on Bose-Einstein Condensation and Quantum Crystals" by G.V. Chester, Phys Rev. A (1970)
- How is it possible to measure supersolidity?
  - Torsional Oscillator
  - What would signal its existence within the data?
- Kim and Chan's experimental data confirming the existence
  - "Probable observation of a supersolid helium phase" by Kim and Chan, Nature (2004)
- Controversy over experimental data
  - Certain processes eliminate the characteristics that signaled supersolidity
  - Experimental data that support its nonexistence
- Alternate explanation for what is occurring at low temperatures
- Chan and Kim's reaction to experimental data against their case
- Future for Supersolids?
  - Possibilities in optical lattices
  - "Dynamical Creation of a Supersolid in Asymmetric Mixtures of Bosons", Phys Rev. Letters (2009)
  - Maybe it does not exist at all.

Vortex State in type 11 superconductors

What is a superconductor
Type I and type II differences
transition (sharp or gradual)
penetrating magnetic field
What is the vortex state
penetrating flux lines
vortex supercurrents
Core size
how many are present
distribution
Uses of vortex states

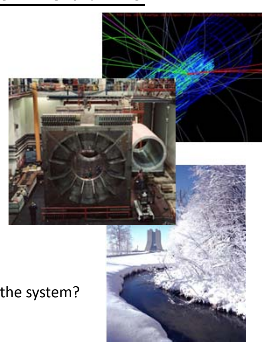
Superconducting Magnets – Outline

Introduction – What is a superconducting magnet?
History – Heike Kamerlingh Onnes, GeorgeYntema, and type-II superconductors
Materials and Operation – How a superconducting magnet works. Persistent mode.
Advantages/Disadvantages – Comparison to regular magnets.
Applications
- MRI/NMR
- Paricle Accelerators

Nuclear Demagnetization

- History, what is it, temperature ranges
- Magnetism in materials
- Principles: entropy cycle (main focus)
- Nuclear vs paramagnetic salts
- Laboratory setup (main focus)
- Limitations, external fields, H/T
- Multiple stages, improved technologies

CDF Cryo System Outline



- What is CDF
  - Where is it? What does it do?
  - Why does it need to be cold?
  - How cold does it get?
- Cryo Systems
  - What are the main components?
  - Where is the helium stored?
  - What is the refrigeration cycle used?
  - Refrigerator diagram
  - Heat exchange system
  - Expansion Engine used, how fast is it?
  - Liquefaction of Helium
  - How do they monitor the system?
  - How do they measure temperature in the system?
  - Controlling the system

Snowball

Quantum Computing

- What is quantum computing
  - How is it different from regular computers
    - Quantum bit
    - Quantum Gates
    - Quantum Circuits
  - Why is it better
    - Faster
    - Capable of modeling quantum systems
    - Quantum Cryptography
- History of Quantum Computing
  - Feynman
  - Shor's factorization algorithm
- Why Cryogenics
  - Needs to be superconducting
  - Only exhibits quantum behavior near absolute zero
- Obstacles
  - Error Correction
  - Decoherence
  - Hardware architecture
    - Nuclear Magnetic Resonance
- Future of Quantum Computing
  - Progress is being made
    - Currently there are computers that use a few qubits, within a few years, the number of qubits is expected to increase significantly

- http://www.cs.rice.edu/~taha/teaching/05F/210/news/2005_09_16.htm
- http://www.nytimes.com/2010/11/09/science/09compute.html
- Quantum Computing by Jozef Gruska
- http://plato.stanford.edu/entries/qt-quantcomp/#Rel

Cryogenics Symposium

Day 3– Thursday April 7, 2011

1.	Laser Cooling of Solids	Pedro Quintero
2.	A short introduction to BEC	Xiaochang Miao
3.	Solitons in BEC	Yitzak Calm
4.	Sperm/Egg Preservation	Alessa Bastron
5.	Cryo-Surgery	Niresh Shukla
6.	Cryo-Ablation	Peter Boulos

Laser cooling of solids

1. History
2. Anti-Stokes fluorescence
3. Basic Principles
4. Experimental Setup
5. Cryocooler Applications

[1] S.A. Egorov and J.L. Skinner, *On the theory of multiphonon relaxation rates in solids,* J. Chem. Phys. **103**, 1533 (1995).

A short introduction to BEC

1. What's Bose-Einstein Condensation? (2 slides)
2. How to experimentally realize BEC?
   a. magnetic trap (1 slide)
   b. cooling method (2 slides)
3. Brief history of BEC (1 slide)
4. Future Applications (1 slide)

Solitons in BEC

February 20, 2011
Yitzi Calm

1. Title: Propagation of Waves in BEC
2. What is a BEC?
3. what is a wave? what is a soliton?
4. Techniques at ultra low temperatures
   1. magnetic trap
   2. evaporative cooling
   3. laser cooling

Waves and solitons in BEC:

5. M. R. Andrews *et al*. Phys. Rev. lett. **79**, 553 (1997)
6. C. Becker *et al*. Nature Phys. **4**, 496 (2008)
7. I. Shomroni *et al*. Nature Phys. **5,** 193 (2009)
8. Conclusion: Physics! #1! Yeah!

Sperm/Egg Preservation Outline- Bastron

I. History of sperm/egg cryopreservation
II. Various methods of preservation (slow freezing, vitrification, vapour freezing, etc.))
III. Different cryoprotectants (Pros/Cons)
IV. Freezing and thawing (time/method) results
V. Effects of preservation (vitality, mobility, defects)
VI. New discovery/developments such as virus removal during freezing (HIV, hepatitis, etc)

(SOME OF THE OBOVE TOPICS WILL REQUIRE MULTIPLE SLIDES, THAT'S WHY THERE ARE ONLY 6)

Cryosurgery - Outline

- What is Cryosurgery? Using cold temperatures to kill harmful cells or abnormal tissue
- What does Cryosurgery treat? Different types of cancerous and precancerous conditions, including: liver cancer, prostate cancer, cervical cancer, and tumors of the bone, among many others
- Equipment: ultrasound, computed tomography, MRI, cryoprobe, bronchoscope, sterile procedure room
- How does it work? Liquid Nitrogen or argon gas is circulated through a cryoprobe, which is placed in contact with the tumor
  – Either ultrasound , CT, or MRI is used to guide probe
- Possible side effects: depends on area being treated, but can include loss of fertility, scarring, nerve damage, impotence, incontinence
- Advantages: less invasive, pain and bleeding minimized, cost, less destruction of healthy tissue, can be used on patients who can't have surgery or radiation therapy
- Disadvantages: uncertainty of long term effectiveness, can only treat cancer that is localized and has not spread
- Future? Still a relatively young technology, thus further studies are necessary to determine long term effectiveness and effective with other types of treatment
- Sources: http://www.cancer.gov/cancertopics/factsheet/Therapy/cryosurgery
  http://www.livercancer.com/treatments/cryosurgery.html
  http://www.radiologyinfo.org/en/info.cfm?pg=cryo

cryoablation

Slide 1- Define cryoablation
Slide 2- Different uses for cryablation/advantages of use
Slide 3- Diagram of cryoablation clinical set-up
Slide 4- The function of the apparatus and required equipment
Slide 5- Cell response to cryoablation
Slide 6- Cell response to cryoablation
Slide 7- Cell response to cryoablation
Slide 8- Cell response to cryoablation
Slide 9- Video of cryoablation
Slide 10- Cryoablation in the news
Slide 11- Past/further studies
Slide 12- Sources

Cryogenics Symposium

Day 4 – Tuesday April 12, 2011

1.	Liquefied Natural Gas	Benjamin Bobrof
2.	Cryogenics in SABRE Engine	Jason Christopher
3.	Cryogenic Propellants for Space Vehicles	Darsa Donelan
4.	Cryogenics Helping the Military	Glenn Mendez
5.	Cryote Project	Dylan Fitzpatrick
6.	Cryo-Chilldown	Dan Zhoa

Liquefied Natural Gas

- General Information
- Liquefication
- Transportation
- Sale
- Environmental Issues
- Safety
- Treatment
- Technology

– Cryogenics in the SABRE Engine

Symposium Outline – Jason Christopher
Title Slide – Cryogenics in the SABRE Engine
Overview
    History
    Design of SABRE Engine
    Pre-Cooler
    Compressor
    Helium Loop
History
    Pre-cooling idea started in 1950's along with liquid air cycle engines (LACE)
    Details of how system was designed to work
    HOTOL engine was simpler than LACE engine
    Problems with patents and the Official Secrets Act led to creation of SABRE
Design of SABRE Engine
    Not a rocket or jet engine
    Pre-cooled turbo rocket; burns air, liquid oxygen, and hydrogen
Pre-Cooler
    Compression of supersonic/hypersonic airflow creates incredible heat as it enters engine
    Heavy metals can't be used as in normal jet engines to cool incoming air
    Liquid helium loop cools air from 1000 C to -140 C in SABRE engine
Compressor
    SABRE compressor similar to conventional jet engine compressors
    The low air temperature from the pre-cooler allows compressor to function at very high pressure ratios
    Driven by gas turbine from waste heat collected from helium loop
Helium Loop
    Warmed helium from pre-cooler and combustion chambers recycled through heat exchanger with liquid hydrogen
    Brayton-cycle engine
    Used to cool critical parts and also powers miscellaneous parts of the engine as well
Conclusion
    History
    Design of SABRE Engine
    Pre-Cooler
    Compressor
    Helium Loop

http://industries-news.blogspot.com/2010/07/air-breathing-engines-and-ramjet.html
http://www.reactionengines.co.uk/sabre.html

Cryogenic Propellants for Space Launch Vehicles

- Flight performance
  - Space flight
  - Effect of propulsion system
  - Flight vehicles
  - Flight stability
- Liquid propellant rocket engine fundamentals
  - Types of propellants
  - Tanks and feed systems
  - Rocket and engines
  - Valves and pipelines
- Liquid propellants
  - Propellant properties
  - Liquid oxidizers, fuels, and monopropellants
  - Gelled and gaseous propellants
- Liquid propellant combustion and its stability
  - Combustion process
  - Analysis and simulation
  - Combustion instability
- SpaceX mission – Falcon 9

! Cryogenics: helping our armed forces

Glenn Mendez
Title
! Cryogenics: helping our armed forces
• Note, a working title
Who is in charge of the cryogenics?
! MM-4201 Cryogenics Technician
Requirements
Responsibilities
! MM-4283 High and Low Pressure Cryogenic Technician
Requirements
Responsibilities
! Interview with an MM-4201 or MM-4283
Why do we need cryogenics in the armed forces?
! Liquid Hydrogen and Oxygen Used as propellants
Explain how they work
Explain where they are used
! Liquid Oxygen and Nitrogen used as breathing Oxygen for fighter pilots
Explain how they work
! Clicker Question
! Acknowledgements

Cryote-Pages and topics for discussion

(some bullets will have more than one page).

- What is CRYOTE?
  - Will detail the proposed mission as per the published *Micro-gravity Cryogenic Experiment Opportunity* article.
  - Who is involved? I will briefly discuss the United Launch Alliance, Innovative Engineering Solutions, NASA, and etc.
- The benefits of completing the CRYOTE mission.
  - Outline what scientists will gain from this mission as opposed to the terrestrial testing.
  - Possible further space exploration with fueling depots ,and cost effectiveness in future space transportation.
  - Outline some of the multiple studies looking to tag along with the CRYOTE mission.
- Possible CRYOTE stoppers.
  - Funding for the 'space depots' will not be a critical path.
  - Non shuttle derived launch vehicles are hard to get political support.
- The microgravity team at UF and our proposed research.
  - Briefly discuss what our team proposed – analyze the cryogenic chilldown rates in reduced gravity.

[1] Wollen, Mark A., Mari Gravlee, Wesley Johnson. *Cryogenic Orbital Testbed (CRYOTE) On-track for Ground Testing and Potential Launch*. "CPIAC Bulletin" Vol. 36, No.4. July 2010.
[2] Gravlee Mari, Chris Vera, Mark Wollen, et al. *Micro-gravity Cryogenic Experiment Opportunity*. AIAA SPACE 2010 Conference & Exposition. 30 August – 2 September 2010. AIAA 2010.
[3] Gravlee Mari, Bernard Kutter, Mark Wollen, et al. *CRYOTE (Cryogenic Orbital Testbed) Concept*. Proposal. 2009.
[4] …more to come… (there are plenty). I've actually been talking with Wesley Johnson from [1] for our reduced gravity experiment, and just recently realized he co-authored an article on the CRYOTE mission. I have emailed him in hopes of finding still more sources.

CHILLDOWN PROCESS OF CRYOGENIC TRANSPORT LINES IN REDUCED GRAVITY
Brief overview
  Background
  Previous research
  Current test objectives
System description
  Equipment
  Structural analysis
  Experiment & Procedure
  Safety/hazard analysis
Data & Analysis
  Analysis procedure
  Expected results

Cryogenics Symposium

Day 5 – Thursday April 14, 2011

1.	Cryogenics for Telescopes	Justin Hugon
2.	HTC SC Power Transmission Lines	Marcus Peprah
3.	Cooling CMS	Mohammed Zakaria
4.	Cryo-Grinding	Zachary Roberts
5.	Cryo-Cleaning	Luronne Vaval
6.	Cryo-Hazards/Safety	Adam Sandwell

Cryogenics for Telescopes

Justin Hugon

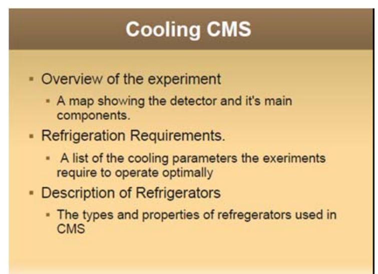
- Why use cryogenics on telescopes?
- Cryogenic Telescopes In Space
  - Infrared Astronomy
    - Necessity of Low Temperatures
    - Instrumentation
  - Gamma Ray Spectrometers
    - Instrumentation
- Future Cryogenic Gravitational Wave Telescopes
  - Merits
  - Challenges

Cryogenics Symposium, Spring 2011

High Temperature Superconductors in Power Technology

Outline

- High Tc Superconductors (HTS)
- What are they?
- Examples and Uses [focus on electric power usage]
  - Power distribution cables
  - Magnetic-energy storage devices
  - Fault Current Limiters
- HTS In Electric Power Distribution
- Materials and conditions for power technology
- Structure of an HTS Cable
- Advantages and Disadvantages of HTS in power applications
- Summary



Cryogenic Grinding!

Part 1: What is cryogenic grinding?
Part 2: What does cryogenic grinding do for materials?
-How it differs from normal grinding
-Cryomilling
Part 3: What kind of materials is it used for?
-Thermoplastics
-Soft Materials
-Elastomers
Part 4: Conclusion

Cryo Cleaning-Dry Ice Blasting

- About dry ice
  - Manufacturing
  - Demo(possibly)
- History of dry ice cleaning
  - Early beginnings
  - Where it is today
- How it works
  - Methods of cleaning
  - How the cleaning works
- Equipment
  - Single hose technology
  - Two hose technology
- Uses of dry ice cleaning today
  - Companies
  - What dry ice cleaning is used on
- Benefits of dry ice cleaning
  - Economic and environmental benefits
- Safety hazards

Cryogenic Hazards

Adam Sandwell

- Low Temperature (duh)
    - Liquid range of plethora of cryogens
    - Effect of such temperatures on human bodies
    - Effect of such temperatures on equiptment
- Flammability
    - Hydrogen
    - Methane
    - Natural Gas
- Asphyxiation
- Rapid Expansion
- Pressure Buildup Due to Solids
- Oxygen
    - Supports combustion
    - Boompics
- Environmental Impact
    - Toxicity
    - Atmospheric Impact
- Laws & Regulations
    - Transport
    - Use
    - Acquisition