

## MAGNETIC REFRIGERATORS

<b>Design of an Active Magnetic Regenerator Test Apparatus .....</b>	<b>995</b>
A. M. Rowe and J. A. Barclay	
<b>Static and Dynamic Force Balancing in Reciprocating Active Magnetic Refrigerators .....</b>	<b>1003</b>
A. M. Rowe and J. A. Barclay	
<b>Fabrication and Testing on Monolithic Single Bin Bed by Low Temperature Epoxy Bonding .....</b>	<b>1011</b>
E. Luo, J. A. Barclay, P. G. Reedeker, and T. W. Wysokinski	
<b>High Temperature Superconducting Magnetic Refrigeration.....</b>	<b>1019</b>
P. E. Blumenfeld, F. C. Prenger, A. Sternberg, and C. Zimm	
<b>Development of Magnetic Refrigerator for Room Temperature Application.....</b>	<b>1027</b>
N. Hirano, S. Nagaya, M. Takahashi, T. Kuriyama, K. Ito, and S. Nomura	

## PART B

### AEROSPACE CRYOCOOLERS

<b>Overview of NASA Space Cryocooler Programs .....</b>	<b>1037</b>
R. F. Boyle and R. G. Ross, Jr.	
<b>The Ball 12 K Stirling Cryocooler .....</b>	<b>1045</b>
W. J. Gully and D. Glaister	
<b>TES Cryocooler System Design and Development.....</b>	<b>1053</b>
S. A. Collins, J. I. Rodriguez, and R. G. Ross, Jr.	
<b>A Low Temperature Turbo-Brayton Cryocooler for Space Applications .....</b>	<b>1061</b>
W. L. Swift, J. A. McCormick, and M. V. Zagarola	
<b>On the Development of Co-Axial Miniature Pulse Tube Coolers for Space Applications .....</b>	<b>1069</b>
Y. Zhou, J. T. Liang, W. Q. Zhu, J. H. Cai, and Y. L. Ju	
<b>High Efficiency Cryocooler .....</b>	<b>1077</b>
E. Tward, C. K. Chan, R. Colbert, C. Jaco, T. Nguyen, R. Orsini, and J. Raab	
<b>Off-State Conductance Measurements of the NIST/Lockheed Martin Miniature Pulse Tube Flight Cryocooler: Laboratory vs. Space .....</b>	<b>1085</b>
D. R. Ladner, R. Radebaugh, and P. Bradley	
<b>Blind Vortex Tube as Heat-Rejecting Heat Exchanger for Pulse Tube Cryocooler .....</b>	<b>1093</b>
M. P. Mitchell, D. Fabris, and R. O. Sweeney	
<b>Current and Future Air Force Space Cryogenic Technology Development .....</b>	<b>1101</b>
B. J. Tomlinson, T. M. Davis, S. D. Hill, and C. H. Bruninghaus	

<b>Performance Characterization of the Astrium 10K Developmental Cryocooler .....</b>	<b>1109</b>
C. H. Y. Bruninghaus, J. P. Kallman, B. J. Tomlinson, Jr., and E. Myrick	
<b>The Next Generation Ball 35 K Cryocooler .....</b>	<b>1117</b>
E. D. Marquardt, W. J. Gully, D. S. Glaister, and G. P. Wright	
<b>Thermodynamic Optimization of Multi-Stage Cryogenic Systems .....</b>	<b>1123</b>
C. S. Kirkconnell and D. G. T. Curran	
<b>Suppression of Cryocooler Induced Microphonics in Infrared Imagers.....</b>	<b>1133</b>
A. M. Veprik, V. I. Babitsky, N. Pundak, and S. V. Riabzev	
<b>Technical Diagnostics of Linear Split Stirling Cryocooler through the Analysis of Self-Induced Forces .....</b>	<b>1141</b>
S. V. Riabzev, A. M. Veprik, and N. Pundak	
<b>Model for Two-Stage Pulse Tube Cold Head Parasitic Heat Load .....</b>	<b>1149</b>
D. R. Lardner	
<b>Optimization of Cold Head for Miniature Stirling Cryocooler .....</b>	<b>1157</b>
H. K. Agrawal and K. G. Narayankhedkar	

## AEROSPACE MAGNETIC COOLERS

<b>Heat Switch Limitations on Multi-Stage Magnetic Refrigeration .....</b>	<b>1167</b>
P. Kittel	
<b>Passive Gas-Gap Heat Switches for Use in Adiabatic Demagnetization Refrigerators .....</b>	<b>1175</b>
P. J. Shirron, E. R. Canavan, M. J. DiPirro, M. Jackson, J. Panek, and J. G. Tuttle	
<b>A Magnetoresistive Heat Switch for the Continuous ADR .....</b>	<b>1183</b>
E. R. Canavan, M. J. Dipirro, M. Jackson, J. Panek, P. J. Shirron, and J. G. Tuttle	
<b>Rare-Earth Garnets and Perovskites for Space-Based ADR Cooling at High T and Low H .....</b>	<b>1191</b>
T. T. King, B. A. Rowlett, R. A. Ramirez, P. J. Shirron, E. R. Canavan, M. J. DiPirro, J. S. Panek, J. G. Tuttle, R. D. Shull, and R. A. Fry	

## AEROSPACE SORPTION COOLERS

<b>Performance Prediction of the Planck Sorption Cooler and Initial Validation.....</b>	<b>1201</b>
M. Prina, P. Bhandari, R. C. Bowman, L. A. Wade, D. P. Pearson, and G. Morgante	
<b>Characterization and Lifecycle Testing of Hydride Compressor Elements for the Planck Sorption Cryocooler .....</b>	<b>1209</b>
D. Pearson, R. C. Bowman, Jr., M. E. Schmelzel, M. Prina, P. Bhandari, C. G. Paine, and L. A. Wade	
<b>Cryogenic System Design for a Hydrogen Sorption Cooler .....</b>	<b>1217</b>
A. Sirbi, R. C. Bowman, Jr., L. A. Wade, and D. S. Barber	

<b>Low-Power, Zero-Vibration 5 K Sorption Coolers for Astrophysics Instruments</b> .....	<b>1225</b>
L. A. Wade and C. A. Lindensmith	
<b>SoCool: A 300 K–0.3 K Pulse Tube/Sorption Cooler</b> .....	<b>1233</b>
L. Duband, L. Clerc, and A. Ravex	

## CRYOGENIC SPACE APPLICATIONS

<b>Operational Cryogenic Experience with the Gravity Probe B Payload</b> .....	<b>1241</b>
M. A. Taber, D. O. Murray, J. R. Maddocks, and K. M. Burns	
<b>A Cryogenic Platform for Space-Borne Instruments with Nanokelvin Stability</b> .....	<b>1249</b>
W. Holmes, R. Bamford, T. C. P. Chui, J. Craig, S. Elliott, S. Galloway, J. Gannon, S. Park, P. Rentz, and J. Thomassen	
<b>Performance, Reliability, and Life Issues for Components of the Planck Sorption Cooler</b> .....	<b>1260</b>
R. C. Bowman, Jr., M. Prina, M. E. Schmelzel, C. A. Lindensmith, D. S. Barber, P. Bhandari, A. Loc, and G. Morgante	
<b>Demonstration of an Efficient Cooling Approach for SBIRS-Low</b> .....	<b>1268</b>
S. J. Nieczkoski and E. A. Myers	
<b>Large Scale Demonstration of Liquid Hydrogen Storage with Zero Boiloff</b> .....	<b>1276</b>
A. Hedayat, L. J. Hastings, C. Bryant, and D. W. Plachta	
<b>Modeling and Test Data Analysis of a Tank Rapid Chill and Fill System for the Advanced Shuttle Upper Stage (ASUS) Concept</b> .....	<b>1284</b>
R. H. Flachbart, A. Hedayat, and K. A. Holt	
<b>Ultra-Light Flexible Temperature and Liquid Level Sensing Probe for Cryogenic Propellant Mass Gauging Systems.</b> .....	<b>1292</b>
M. S. Haberbusch	

## HELIUM II

<b>Subcooled He II Heat Transport in the Channel with Abrupt Contractions/Enlargements</b> .....	<b>1303</b>
R. Maekawa, A. Iwamoto, S. Hamaguchi, and T. Mito	
<b>He II Co-Current Two Phase Flow at High Vapor Velocities</b> .....	<b>1311</b>
B. Rousset, B. Jager, E. di Muoio, L. Puech, P. Thibault, R. Vallcorba, R. van Weelderen, and P. E. Wolf	
<b>Sloshing of Superfluid Helium in a Viscous Damping Matrix</b> .....	<b>1319</b>
H. A. Snyder	
<b>Experiments of Highly Transient Thermo-Fluid Dynamic Phenomena in He II Induced by Gas Dynamic Shock Wave Impingement</b> .....	<b>1327</b>
H. Nagai, H. S. Yang, Y. Ueta, K. Yanaka, and M. Murakami	
<b>A Study on the Temperature Dependent Drag Coefficient on a Sphere in Flowing Helium II</b> .....	<b>1335</b>
Y. S. Choi, M. R. Smith, and S. W. Van Sciver	

<b>Observation of Cavitation in Superfluid Helium .....</b>	<b>1343</b>
K. Nishigaki, M. Takeda, and N. Inoue	
<b>Integral Method for Transient He II Heat Transfer in a Semi-Infinite Domain .....</b>	<b>1349</b>
B. Baudouy	
<b>Transient Heat Transfer on a Flat Plate at One End of a Duct with an Orifice in Pressurized He II.....</b>	<b>1356</b>
M. Shiotsu, K. Hata, K. Hama, H. Tatsumoto, and Y. Shirai	
<b>Critical Heat Fluxes on a Flat Plate Pasted on One End of a Rectangular Duct with an Orifice in Pressurized He II .....</b>	<b>1364</b>
H. Tatsumoto, K. Hata, K. Hama, Y. Shirai, and M. Shiotsu	
<b>Application of PIV to Counterflow in He II.....</b>	<b>1372</b>
D. Celik, T. Zhang, and S. W. Van Sciver	
<b>Study of Thermal Shock Wave in Shock-Compressed He II Induced by Gas Dynamic Shock Wave Impingement.....</b>	<b>1380</b>
H. S. Yang, Y. Ueta, H. Nagai, M. Murakami, and K. Yanaka	
<b>Study of Evaporation from He II Free Surface Induced by Thermal Shock Wave .....</b>	<b>1388</b>
M. Murakami, M. Maki, J. Fujiyama, and T. Furukawa	

## **FLUID MECHANICS AND HEAT TRANSFER**

<b>A Cryogenic High-Reynolds Turbulence Experiment at CERN.....</b>	<b>1399</b>
A. Bézaguet, J.-P. Dauvergne, S. Knoops, P. Lebrun, M. Pezzetti, O. Pirotte, J.-L. Bret, B. Chabaud, G. Garde, C. Guttin, B. Hébral, S. Pietropinto, P. Roche, J.-P. Barbier-Neyret, C. Baudet, Y. Gagne, C. Poulain, B. Castaing, Y. Ladam, and F. Vittoz	
<b>Thermal Oscillations in Liquid Helium Targets.....</b>	<b>1407</b>
L. Wang and L. X. Jia	
<b>Numerical Simulation of Cavitating Flow of Liquid Helium in a Pipe Using Multi-Fluid Model .....</b>	<b>1413</b>
J. Ishimoto, M. Oike, and K. Kamijo	
<b>Temperature Measurement and Visualization Study of Liquid Helium Cavitation Flow through Venturi Channel .....</b>	<b>1421</b>
T. Ishii and M. Murakami	
<b>Performance Tests of Industrial Prototype Subcooling Helium Heat Exchangers for the Large Hadron Collider .....</b>	<b>1429</b>
P. Roussel, A. Bézaguet, H. Bieri, R. Devidal, B. Jager, R. Moracchioli, P. Seyfert, and L. Tavian	
<b>Single-Phase Helium Recooling in a Tevatron Spool Piece.....</b>	<b>1437</b>
A. L. Klebaner and J. C. Theilacker	
<b>Quick Cooling and Filling through a Single Port for Cryogenic Transfer Operations .....</b>	<b>1445</b>
J. R. Jones and J. E. Fesmire	
<b>An Experimental Study of Cold Helium Dispersion in Air .....</b>	<b>1452</b>
M. Chorowski, G. Konopka, and G. Riddone	

<b>Critical Heat Flux on a Flat Plate in a Pool of Subcooled Liquid Helium . . . . .</b>	<b>1460</b>
K. Hata, H. Nakagawa, H. Tatsumoto, Y. Shirai, and M. Shiotsu	
<b>Short Profile Rectangular Helium Cryostat Made from Nickel–Iron Alloy . . . . .</b>	<b>1468</b>
R. A. Rucinski	
<b>Performance of Thermal Shields of LHD Cryostat Cooled by Gaseous Helium with Parallel Paths . . . . .</b>	<b>1475</b>
S. Imagawa, H. Tamura, N. Yanagi, H. Sekiguchi, T. Mito, and T. Satow	
<b>Study on the Overall Heat Transfer Coefficient for the Tube-in-Tube Heat Exchanger Used in Mixed-Gases Coolers . . . . .</b>	<b>1483</b>
M. Q. Gong, J. F. Wu, E. C. Luo, Y. F. Qi, Q. G. Hu, and Y. Zhou	
<b>Development of Small 2K Cryocooler (II)—High Efficient and Low Pressure Drop Heat Exchanger . . . . .</b>	<b>1491</b>
H. Nagai, A. Sato, S. Nimori, K. Numasawa, M. Maeda, F. Matsumoto, M. Takahashi, K. Ohsemochi, T. Kuriyama, T. Fujioka, K. Kitagawa, and T. Okamura	
<b>Boiling Heat Transfer Characteristics of Liquid Xenon . . . . .</b>	<b>1499</b>
T. Haruyama	
<b>Experimental Study on the Limit of Superheat of Normal-Hydrogen and Para-Hydrogen . . . . .</b>	<b>1507</b>
K. Nishigaki, M. Takeda, and N. Takagi	
<b>Heat and Mass Transfer in Two-Phase HE I Thermosiphon Flow . . . . .</b>	<b>1514</b>
B. Baudouy	

## THERMAL INSULATION

<b>Thermal Insulation Performance of Flexible Piping for Use in HTS Power Cables . . . . .</b>	<b>1525</b>
J. E. Fesmire, S. D. Augustynowicz, and J. A. Demko	
<b>Overall Thermal Performance of Flexible Piping Under Simulated Bending Conditions . . . . .</b>	<b>1533</b>
J. E. Fesmire, S. D. Augustynowicz, and J. A. Demko	
<b>Aerogel Beads as Cryogenic Thermal Insulation System . . . . .</b>	<b>1541</b>
J. E. Fesmire, S. D. Augustynowicz, and S. Rouanet	
<b>Thermal Conductivity Measurements of Aerogel-Impregnated Shuttle Tile at Cryogenic Temperatures . . . . .</b>	<b>1549</b>
B. P. M. Helvensteijn, J. R. Maddocks, L. J. Salerno, P. R. Roach, P. Kittel, and S. M. White	
<b>Analytical Modeling of Variable Density Multilayer Insulation for Cryogenic Storage . . . . .</b>	<b>1557</b>
A. Hedayat, L. J. Hastings, and T. Brown	
<b>Lightweight Multilayer Insulation to Reduce the Self-Compression of Insulation Films . . . . .</b>	<b>1565</b>
T. Ohmori, M. Nakajima, A. Yamamoto, and K. Takahashi	

<b>The Effect of Non-Zero Thermal Radiation Transmissivity of the Aluminized Mylar Film on the Thermal Performance of Super-Insulation .....</b>	<b>1573</b>
T. Ohmori, A. Yamamoto, and M. Nakajima	

## CRYOGENIC INSTRUMENTATION AND CONTROLS

<b>Electronic Components and Systems for Cryogenic Space Applications .....</b>	<b>1585</b>
R. L. Patterson, A. Hammoud, J. E. Dickman, S. Gerber, M. E. Elbuluk, and E. Overton	
<b>Thermal Valves for Cryogenic Temperature Control .....</b>	<b>1592</b>
G. E. McIntosh and G. D. Mordhorst	
<b>Non-linear Advanced Control of the LHC Inner Triplet Heat Exchanger Test Unit .....</b>	<b>1597</b>
E. Blanco Viñuela, J. Casas-Cubillos, C. de Prada Morago, and S. Cristea	
<b>Adaptive Vibration Reduction Controls for a Cryocooler with a Passive Balancer .....</b>	<b>1605</b>
G. Kopasakis, J. E. Cairelli, and R. M. Traylor	
<b>A Miniature Palladium–Iron Thermometer for Temperatures down to 0.05 Kelvin .....</b>	<b>1613</b>
J. G. Tuttle, M. J. DiPirro, E. R. Canavan, P. J. Shirron, E. Kunes, and T. P. Hait	
<b>A New Cryogenic Diode Thermometer .....</b>	<b>1620</b>
S. S. Courts, P. R. Swinehart, and C. J. Yeager	
<b>Magnet Options for Sensors for the Pulp and Paper Industry .....</b>	<b>1628</b>
M. A. Green, P. J. Barale, C. G. Fong, A. Luft, J. A. Reimer, and M. S. Yahnke	
<b>Long-Term Stability of a Cryogenic Diode Thermometer .....</b>	<b>1636</b>
S. S. Courts and P. R. Swinehart	
<b>Thermal Resistance of Cryogenic Thermometers at Ultra-Low Temperatures .....</b>	<b>1644</b>
C. J. Yeager, S. S. Courts, and W. E. Davenport	
<b>A Low Noise, High Thermal Stability, 0.1 K Test Facility for the Planck HFI Bolometers .....</b>	<b>1651</b>
C. G. Paine, J. J. Bock, V. V. Hristov, and A. E. Lange	
<b>Towards the Invisible Cryogenic System for Magnetic Resonance Imaging .....</b>	<b>1659</b>
F. Steinmeyer, P. W. Retz, K. White, A. Lang, W. Stautner, P. N. Smith, and G. Gilgrass	
<b>Void Fraction Measurement in Two-Phase Helium Flow with Electron Energy Attenuation Detector .....</b>	<b>1667</b>
L. Augyrond, P. Ageron, H. Blumenfeld, P. Bredy, and J.-C. Lugol	
<b>Optical Investigations of HE II Two Phase Flow .....</b>	<b>1675</b>
E. di Muoio, B. Jager, L. Puech, B. Rousset, P. Thibault, R. van Weelderen, and P. E. Wolf	

<b>Probing the Wetted Perimeter in a He II Two-Phase Pipe-Flow Experiment Using a Capacitive Sensor .....</b>	<b>1683</b>
P. Thibault, E. di Muoio, L. Puech, B. Rousset, and P. E. Wolf	
<b>BaBar Helium Liquefier and Superconducting Magnet Control System .....</b>	<b>1691</b>
W. W. Craddock, A. Angelov, P. L. Anthony, R. Badger, M. Berndt, W. Burgess, A. Candia, G. Oxoby, and C. Titcomb	
<b>In-Situ and Post Irradiation Behavior of Cryogenic Temperature Sensors under Fast Neutron Fluence .....</b>	<b>1700</b>
Y. P. Filippov, V. V. Golikov, E. N. Kulagin, V. M. Miklayev, and A. K. Sukhanova	
<b>NOVEL CONCEPTS</b>	
<b>Magnetically Levitated Space Elevator to Low-Earth Orbit .....</b>	<b>1711</b>
J. R. Hull, T. M. Mulcahy, and R. C. Niemann	
<b>Efficient Two-Level Cryogenic Power Distribution System .....</b>	<b>1719</b>
O. M. Mueller and E. K. Mueller	
<b>Modular Low Temperature Laser Scanning Microscope for High Magnetic Fields .....</b>	<b>1726</b>
M. Peschka, P. Mühlischlegel, and R. Kleiner	
<b>Neutrino Mass Measurements with Cryogenic Microcalorimeters .....</b>	<b>1734</b>
F. Gatti	
<b>CRYOGENIC SAFETY</b>	
<b>Accidents with Cryogenic Fluids and What Can We Learn from Them.....</b>	<b>1743</b>
F. J. Edeskuty	
<b>Safety Issues of Space Liquid-Helium and Solid-Cryogen Systems.....</b>	<b>1759</b>
P. V. Mason	
<b>Simulations of Liquid Argon Accidents in the ATLAS Cavern .....</b>	<b>1768</b>
M. Vadon, B. P. Solano, and F. Balda	
<b>Open Channel Helium Flow during Rupture Event .....</b>	<b>1776</b>
W. M. Soyars and J. L. Schiller	
<b>Investigation of Personal and Fixed Head Oxygen Deficiency Hazard Monitor Performance for Helium Gas.....</b>	<b>1784</b>
D. Arenius, D. Curry, A. Hutton, K. Mahoney, S. Prior, and H. Robertson	
<b>Equations for Gas Releasing Process from Pressurized Vessels in ODH Evaluation .....</b>	<b>1792</b>
L. X. Jia and L. Wang	
<b>Author Index .....</b>	<b>A1</b>
<b>Subject Index .....</b>	<b>S1</b>