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目 录

论文编号：17–001

北京新发地市场SARS-CoV-2传播的危险因素及现场模拟研究

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摘要正文：

从2020年6月11日起，新发地批发市场新型冠状病毒肺炎（COVID-19）新发病例激增，加剧了人们对于北京第二波新冠肺炎疫情的担忧。为了遏制新冠肺炎病例的上升，了解2019新型冠状病毒（SARS-CoV-2）在大型食品批发市场环境中的传播模式以及影响病毒传播的个人行为和环境因素至关重要，然而目前这些还鲜为人知。为此，我们在北京新发地批发市场对新冠肺炎感染率较高的地区进行了实地调查和现场模拟研究。研究发现，销售者和顾客之间的正常交易行为、日常生理活动和营销活动等均可能会导致病毒污染，并通过污染物、液滴或气溶胶等途径在环境中进行播散。低温高湿、通风不良、卫生设施不足等环境因素可能是北京新发地批发市场中新冠病毒传播的影响因素之一。最后，我们提出了预防性控制策略，以有效减少新冠肺炎聚集性疫情在大型批发市场的发生。

关键词：COVID-19；新发地批发市场；海产品；传播模式；荧光微球

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论文编号：17–002

污水处理厂生物气溶胶颗粒的实时在线分析

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摘要正文：

针对污水处理厂产生的生物气溶胶污染物在时间和空间上复杂多变的排放特征，在线的生物气溶胶监测系统因其摒弃了传统离线方法所依赖的割裂式的“采样”——“检测分析”两步骤，而是实时分析了每一个生物气溶胶颗粒的性质，所以可以提供高时间分辨率条件下生物气溶胶单颗粒的在线动态排放特征。而此领域最热点、最为成熟、报道最为广泛的研究方向就是基于激光诱导荧光（LIF, Laser Induce Fluorescence）的单颗粒生物气溶胶实时在线分析。

本研究使用正在研发中的最前沿LIF实时在线分析技术“生物气溶胶光谱强度传感仪（SIBS, Spectral Intensity Bioaerosol Sensor）”，分析了某校园污水处理厂中滴滤池在三天监测采样中的高流量和常规流量情景下生物气溶胶颗粒在不同粒径分布下的荧光光谱特征（图1）。对于高流量情境（图1a），细颗粒（< 1 μm）的模式数多余粗颗粒（> 2.5 μm），不同粒径分布下的生物气溶胶颗粒的荧光光谱特征模式完全不同。这表明污水在滴滤池配水管中高速流动时，产生的生物气溶胶以细颗粒为主，且这些细颗粒生物气溶胶的组成比粗颗粒更为复杂。这些细颗粒生物气溶胶也会相互聚集，从而形成粗颗粒生物气溶胶。对于常规流量情境（图1b），不同粒径分布下的生物气溶胶颗粒的荧光光谱特征模式几乎相同。这是因为在常规流量情境下，生物气溶胶的排放是稳定的，且其受到周围自然和人为环境的绝对控制。两种流量情境下生物气溶胶颗粒的组成没有显著的差别。它们主要的组成生物荧光基团是：氨基酸、辅酶（因子）、维生素、细胞聚合物和细胞壁类物质、染料、次级代谢产物。来自非污水处理过程的干扰生物气溶胶可能是类腐殖酸、叶绿素或者多环芳烃，它们是水厂周围绿地和来往车辆产生的。

本研究的结论是：每个气溶胶单颗粒都被SIBS实时在线分析了：2×16通道的EEM荧光光谱、粒径和形状。其可以较为完善的提供高时间分辨率条件下污水处理厂中生物气溶胶污染物的排放特征。SIBS对于长周期全天候定量和定性分析污水厂生物气溶胶在各种影响（活动）情景下的排放特征，具有无与伦比的优势。

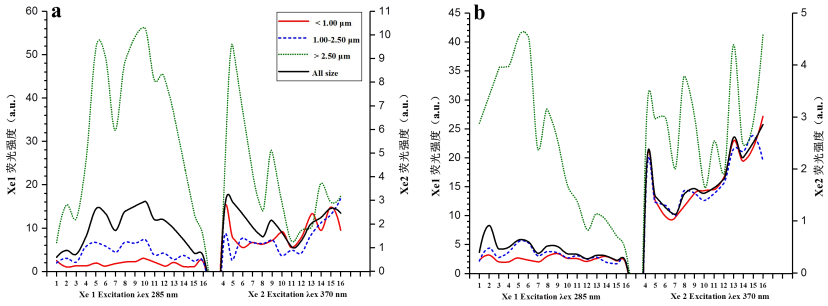

Fig. 1 Fluorescence spectra of size segregated fluorescent bioaerosol particles for scenarios (a) high flow and (b) normal flow

关键词：SIBS；荧光光谱；粒径分布；高流量；常规流量

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SARS-CoV-2 presented in the air of intensive care unit (ICU)

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As coronavirus disease 2019 (COVID-19) is spreading worldwide, there have been arguments regarding the aerosol transmission of its causative agent, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Moreover, some re-detectable positive (RP) patients have been reported. However, little attention has been given to the follow-up of recovered patients, and there is no environmental evidence to determine whether these patients continue to shed the virus after they test negative. Therefore, with an objective to test the hypothesis of airborne transmission of SARS-CoV-2, it is necessary to 1) determine whether SARS-CoV-2 particles are present in the indoor air and 2) determine whether recovered patients are still shedding virus, thus providing much-needed environmental evidence for the management of COVID-19 patients during the recovery period. In this study, surface and air samples were collected from an intensive care unit (ICU) containing one ready-for-discharge patient. All surface samples tested negative, but the air samples tested positive for SARS-CoV-2. This implies that SARS-CoV-2 particles may be shed in aerosol form for days after patients test negative. This finding may be one of the reasons for the observation of RP patients; therefore, there is a need for improved clinical and disease management guidelines for recovered COVID-19 patients.

Keywords: SARS-CoV-2; Aerosol; Ready-for-discharge Patient; Re-detectable Positive; ICU

论文编号：17–004

气流边界层对高分子流体液膜的稳定性影响

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摘要正文：

气流流动与高分子流体液膜的相互作用在自然界与工程界非常普遍，具有重要的基础研究意义。本文以专业相关的呼吸道内衬液液膜与呼吸气流间的相互作用为切入点进行研究，从失稳机制的探究、呼吸道理论模型的建立、CFD流体力学的仿真三个方面对失稳现象进行了论证。

在理论建模方面，对现有的圆柱管内气液两相流模型进行了改进，将液膜模型完善为非牛顿流体模型，增加了对黏液剪切稀化流变特性的参数描述。对于失稳的核心机制Rayleigh-Plateau不稳定性，选用简化的圆柱射流模型进行了推导，得到结论：1、在无惯性以及无粘性假设下，对于波长超过圆柱周长的扰动，系统才是不稳定的；2、扰动波长和波数与非稳定性的增长速率之间的关系是抛物线关系，并能够预测在不同扰动参数下液膜的分离破碎时间。

在CFD仿真模拟方面，模拟了飞沫呼出模型、炎症黏液增多模型以及咳嗽肺内高压气体喷射模型三种生理状况下液膜的失稳现象，得到结论：主动核心流体的速度对液膜稳定性的影响是非线性的。研究了流体的粘度性质以及液膜初始厚度参数的影响，得出结论：1、高粘度非牛顿流体相较于低粘度牛顿流体使得液膜更加稳定，因此非牛顿流体液膜的初始扰动更小。粘度越高，在气体核心作用下流体液膜表面越平稳，界面变形幅度越小；2、初始液膜厚度对于非牛顿流体而言是液膜失稳的核心参数之一，黏液在截面处的体积分数和湍流动能都与液膜初始厚度成反比。液膜厚度的降低了液膜的失稳程度，并且显著减少黏液的聚集。

关键词：气液两相流，Rayleigh-Plateau不稳定性，非牛顿流体，VOF模型

论文编号：17–005

中牧兰州生物制药厂布病事件气溶胶扩散模拟

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摘要正文：

为分析生物气溶胶释放对人群潜在影响风险的情况,利用 CALPUFF 模型定量模拟了2019年7月 24~8月20日中牧兰州生物制药厂布鲁斯菌泄露事件中，含菌气溶胶扩散、浓度空间分布情况，并结合人口数据，对人群潜在健康风险进行了分析,利用公开报道的检测数据开展了验证。结果显示: 生物药厂的含菌气溶胶排放源附近高值区主要集中于厂区四周,影响范围主要以厂区为中心,并向四周逐渐扩散;检测结果中兰州兽研所 1#,兰州大学 2#地区健康风险比例 41.49:1,在模拟的相对风险大小的误差区间(36.15±8.48)范围内,说明本研究含菌气溶胶对人群潜在影响风险的模拟结果可信。

关键词：含菌气溶胶；CALPUFF 模型；健康风险

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论文编号：17–006

The efficacy of social distance and ventilation effectiveness in preventing COVID-19 transmission

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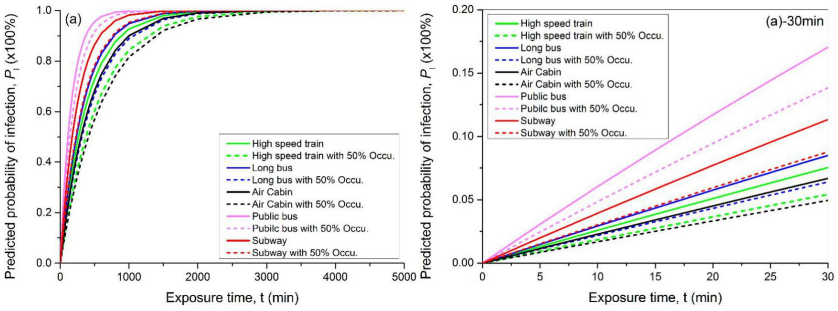
Social distancing and ventilation were emphasized broadly to control the ongoing pandemic COVID-19 in confined spaces. Rationales behind these two strategies, however, were debated, especially regarding quantitative recommendations. The answers to “what is the safe distance” and “what is sufficient ventilation” are crucial to the upcoming reopening of businesses and schools, but rely on many medical, biological, and engineering factors.

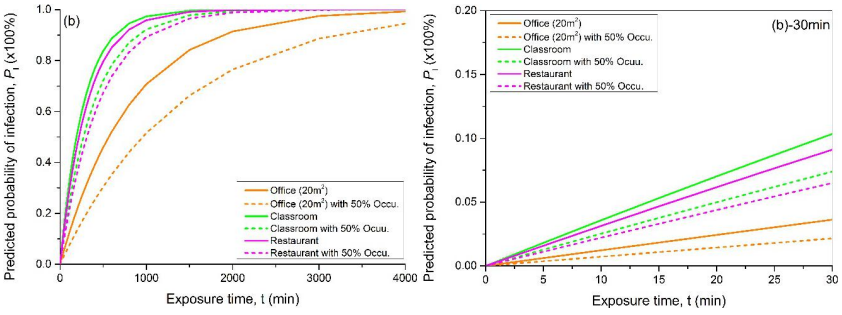
This study introduced two new indices into the popular while perfect-mixing-based Wells-Riley model for predicting airborne virus related infection probability - the underlying reasons for keeping adequate social distance and space ventilation, as seen in Equation (1).

$$P_I=\frac{C}{S}=1\text{-}\exp(-P_d\frac{Iqpt}{Q\cdot E_z}) \quad (1)$$

The distance index P_d can be obtained by theoretical analysis on droplet distribution and transmission from human respiration activities, and the ventilation index E_z represents the system-dependent air distribution efficiency in a space. The study indicated that 1.6–3.0 m (5.2–9.8 ft) is the safe social distance when considering aerosol transmission of exhaled large droplets from talking, while the distance can be up to 8.2 m (26 ft) if taking into account of all droplets under calm air environment. Because of unknown dose response to COVID-19, the model used one actual pandemic case to calibrate the infectious dose (quantum of infection), which was then verified by a number of other existing cases with short exposure time (hours). Projections using the validated model for a variety of scenarios including transportation vehicles and building spaces illustrated that (1) increasing social distance (e.g., halving occupancy density) can significantly reduce the infection rate (20–40 %) during the first 30 min even under current ventilation practices; (2) minimum ventilation or fresh air requirement should vary with distancing condition, exposure time, and effectiveness of air distribution systems, as seen in Figure 1.



(a) Transportation spcaes



(b) Public building spcaes

Fig. 1 Predicted probability of infection for different scenarios

Keywords: COVID-19; Social distance; Ventilation; Infection probability; Wells-Riley model

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论文编号：17–007

办公室内基于触摸行为的污染表面传播研究

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摘要正文：

虽然空气传播和近距离接触被认为是很多呼吸道传染病的主要传播途径[1]，但是由于病毒在表面存活时间较长，表面污染物传播可能在某些呼吸道疾病传播中起到非常重要的作用[2-4]。而病毒在一个建筑或房间内如何通过表面进行传播是关键[5-7]。我们在某大学的学生办公室内安装了多个高清摄像头，收集了超过9万人·秒的人员表面触摸行为数据，统计了早8点至晚10点共14个小时内23名学生双手的表面触摸行为。学生双手平均96.4%的时间都在触摸表面。在所有触摸中，98.4%的触摸表面是私人表面（如自己的身体、椅子、桌子、个人物品等）。本研究首次将双手分别分成手指、手掌和手背三个部分进行统计。结果发现，手指在表面触碰中运用最多。手指、手掌和手背的表面触碰频率分别为480、314和49次/小时。手指触摸粘膜的频率是手掌触摸的10倍，是手背触摸的40倍。病人一天下来，向外界表面释放了自身产生的98.8% 病毒。右手从公共表面获得的病毒量为左手的4倍。但是左手传播至粘膜的病毒量为右手的1.8倍。手指和手掌在病毒传播中的贡献率超过96%，而通过手指传播到粘膜的病毒量为总粘膜病毒吸收量的93%。本研究的结论对病原体通过表面传播有着很好的数据支撑作用，同时对表面传播的预防与控制起到重要作用。

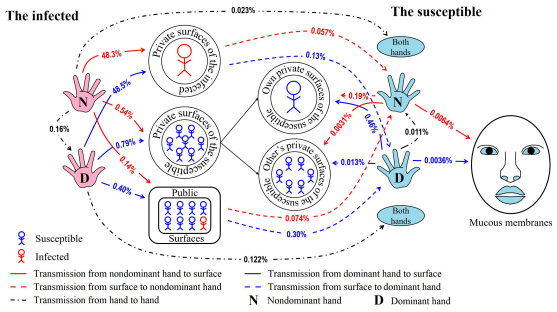

Fig. 1 Virus transmission between finger/palm/back of hands and surfaces

关键词：人员行为；表面触摸；污染表面；室内环境；办公室

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新冠病毒气溶胶扩散概率模型在机场环境中的建立与应用

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摘要正文：

新冠病毒的爆发给全世界带来了灾难，室内环境的安全问题受到了不小的挑战。为控制新冠病毒在机场等公共建筑中的传播，提供有效的空调运行策略，对机场内空气中新冠病毒气溶胶的扩散机理和防控策略进行了研究。首先分析了含病毒气溶胶在空气中扩散的机理，并建立了含感染者空调房间的物理模型；然后建立数学模型用以刻画机场内空气中含病原体气溶胶的数量浓度；之后在含病毒气溶胶颗粒数量浓度模型的基础上假设气溶胶粒子在机场空气中随机分布，提出了吸入含病毒气溶胶的概率模型，可以通过机场内人员在机场停留相应的时间时吸入病毒的概率大小来反映风险水平；最后选择一种典型工况进行算例分析，假设吸入病毒概率不足5%时认为是小概率事件，通过数值方法计算不同通风条件下机场内空气中含毒气溶胶的数量浓度，以及不同含毒气溶胶数量浓度和小概率事件所对应最大滞留时间之间的关系，从而刻画吸入病毒的概率、室内气溶胶浓度以及室内停留时间三者之间的关系。结果表明，当感染者呼气中病毒浓度为50pcs/m^{3}时，为了保证人员在机场停留30分钟内吸入病毒是一个小概率事件，新风量不应小于40m^3/h/人。

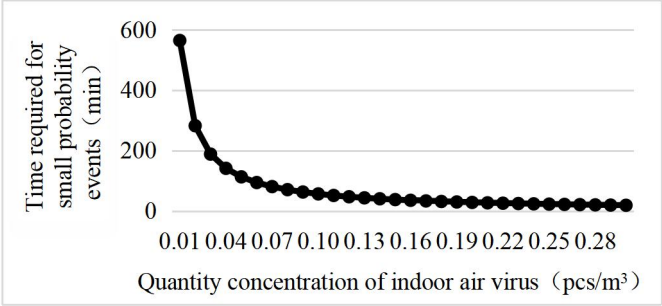

Fig. 1 Relationship between virus concentration and time

关键词：新冠病毒；气溶胶扩散；概率模型；机场

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A Review of Ultraviolet germicidal irradiation(UVGI) for Disinfection of Bioaerosols in Indoor Environment

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Human beings are facing threats from bioaerosols like pollens, mold, bacteria, and viruses in indoor environments. Ultraviolet germicidal irradiation (UVGI) system has been used in both the air-conditioning equipment and indoor environments to improve the indoor air quality and reduce high-energy consumption of ventilation. It applies electromagnetic energy in the UVC spectrum to damage and prevent the replication of microbial DNA and RNA. Both environmental chamber and field studies have unveiled the efficiency of different types of UVGI units on indoor bioaerosols. Different types of UVGI units including in-duct, upper-room, and portable have been evaluated in certain indoor environments. There is still a great gap in the concentration, size-resolved distribution, and UV susceptibility of bioaerosols especially viruses under the effect of the UVGI system to be filled.

Keywords: Indoor air quality, bioaerosol, UVGI, ventilation

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Preparation of A New Type of proteins polymer brushes Modified Silica Beads For bioaerosols monitoring quantity transfer and traceability by atom transfer radical polymerization (ATRP)

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Bioaerosol monitor instrument is a kind of instrument which can count biological particles with fluorescent signal in the environment. At present, there are no national calibration standard particles for this equipment. An optimal traceability calibration bioparticles was established for bioaerosol monitor instrument based on the principle of fluorescence spectroscopy.

Atom transfer radical polymerization (ATRP) developed by Matyjaszewski's group in 1995 [1] is widely used in particles field to formed organic polymer layer on the surface of silica spheres as functional materials. Using ATRP technique, polymer brushes of well determined structure and low polydispersity can be grafted on the surface of silica spheres. Furthermore, the thickness of the polymer brush layer can be well tailored by simply changing the polymerization time [2], and therefore leads to better controlled surface character. Finally, there are numerous of functional groups along the side chains of the polymer brushes, and thus provides a variety of biological active functional groups for tailoring the character of the standard bioaerosols particles for specific applications.

In this work, we prepared a new type of standard particles using protein polymer modified silica microparticles synthesized by atom transfer radical polymerization (ATRP) as the substrate material for simulation of biological particles. Briefly, glycerol monomethacrylate (GMA) polymer brushes were grafted on the silica beads by surface initiated ATRP. Next, Bovine serum albumin (BSA) was coupled to the side chains of GMA polymer brushes to obtain biological active functional groups.

The number of protein polymer grafting on the silica beads and the fluorescent intensity was determined and optimized by varying ATRP reaction system, reaction temperature and reaction time. The optimized ATRP reaction condition is GMA/water/CuCl/CuCl2/isopropanol system grafting at 50°C for six hours. The structure of the protein polymer brushes on the silica beads was characterized by SEM and the fluorescent intensity was characterized by fluorescence spectroscopy.

Studies focusing on further tailoring the biological polymer brushes for traceability calibration of Bioaerosol monitor, such as proteins and amino acid are going on.

Keywords: Bioaerosol; Fluorescence; Particles; Calibration

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吸入制剂新创意的思考

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摘要正文：

介绍了压力定量吸入剂的进展和创新，包括抛射剂创新、配方创新、技术创新和装置创新。其次，介绍了新剂型在临床的新用途，如热挥散吸入剂治精神疾病。最后，探讨了吸入制剂在临床的应用现状，包括多部专家共识相继问世，多组织联合倡议推进PCCM咳喘药学服务门诊。

关键词：吸入制剂；创新；咳喘药学服务

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New ideas of inhalation preparations

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The development and innovation of pressure quantitative inhalant were introduced, including the innovation of propellant, formulation, technology and device. Secondly, the new clinical applications of the new inhaler were introduced, such as the treatment of mental illness with the vaporized inhaler. Finally, the clinical application of inhaled preparations was discussed, including the emergence of expert consensus, and the joint initiative of three organizations to promote PCCM cough and asthma pharmaceutical care.

Keywords: inhalation preparation; innovation; pharmaceutical care for cough and asthma